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THE UREDINEÆ OCCURRING UPON PHRAGMITES, SPARTINA, AND ARUNDINARIA IN AMERICA.[1]

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(WITH FOUR FIGURES)

Upon the several species of Phragmites, Spartina, and Arun dinaria there occur in America one species of Uromyces and six species of Puccinia. There has never existed material confusion regarding the Uromyces species, except to divide it into two upon geographical grounds; but the Puccinia species have been so much confused and misunderstood that one may say with much truth that, whenever a correct determination has been made, it has been due more to good fortune than to clear insight. The most common disposition of these six species has been to list them indiscriminately under *P. Phragmitis* (Schum.) Körn., or possibly under *P. arundinacea* Hedw. or DC., or occasionally under *P. Arundinariæ* Schw. In 1876 Körnicke[2] showed that in Europe two species of Puccinia occur upon Phragmites that are morphologically distinguishable, which he diagnosed under the names *P. Phragmitis* and *P. Magnusiana*. The first of these species appears to be cosmopolitan and occurs in America, but not the second one. This second species is represented by a closely related one, however, which, together with the other four species of Puccinia and one of Uromyces described in this

[1] Presented by title at the Columbus meeting of the Botanical Society of America, Ag 1899.

[2] Hedwigia **15**: 178. 1876.

paper, appears to be exclusively American. Several European species now known to occur upon Phragmites have not yet been found in America.

The writer's attention was first called to the confusion in the American species when studying the uredospores upon Spartina, preparatory to undertaking cultures. The results of subsequent study are now presented in systematic order, and with sufficient fullness, it is believed, to permit of the ready identification of material.

In this paper, whenever actual specimens are cited, the kind and abundance of the spores present are indicated by the cipher and Roman numerals: O. I. II. III. If the spore receptacles are well formed and fairly abundant, large (capital) type is used; and if the spores are few and subordinate, small (lowercase) type is used. Thus, II, iii, indicates that well-formed uredosori are present, but that the teleutosori are comparatively few, or that what teleutospores are present are borne in the uredosori.

Grateful acknowledgment is made to a number of mycologists for the loan of specimens. Professor T. J. Burrill of the University of Illinois, Professor L. H. Pammel of the Iowa State College, Professor W. G. Farlow of Harvard University, Professor L. R. Jones of the University of Vermont, Professor F. S. Earle of the Alabama Polytechnic Institute, and the custodians of the Philadelphia Academy of Sciences and the New York Botanical Gardens, placed a portion of the herbaria under their charge at my disposal; while the following botanists either loaned specimens from their herbaria or gathered material from the field for my use: Messrs. H. L. Bolley, R. I. Cratty, E. W. D. Holway, G. W. Carver, H. H. Hume, J. J. Davis, E. Bartholomew, S. M. Tracy, T. H. MacBride, P. H. Rolfs, L. M Underwood, and C. E. Bessey. I am furthermore especially indebted to Mr. A. B. Seymour for the generous loan of a part of his herbarium, which proved remarkably rich in collections representing nearly all the species covered by this paper.

All figures accompanying this paper are drawn with camera

lucida to a uniform scale of 470 diameters, and all are in vertical section, excepting three uredospores which are in transverse section (see explanation of *figs. 3* and *4*). The pedicels are as carefully drawn as the rest of the spore.

1. UROMYCES ACUMINATUS Arth. 1883, May. Bull. Minn. Acad. Sci. **2**:35.

SYN.: 1883, July. *Uromyces Spartina* Farl. Proc. Amer. Acad. Sci. **18**: 77.

EXSICC.: Ellis, N. Amer. Fungi, 239[III], 1443[III].
Sydow, Uredineen, 251[III].
Seymour and Earle, Econ. Fungi, 67[III], 68[III], 546[III].

O. I. Spermogonia and aecidia unknown.

II. III. Sori epiphyllous, intercostal, linear, soon naked, ruptured epidermis conspicuous. II. Uredosori yellowish, inconspicuous; uredospores globose or broadly elliptical, large, 22–35μ in diameter, average 30μ, wall golden yellow, thick while immature, becoming thin, echinulate with low, stout points, pores 5 to 8, scattered. III. Teleutosori blackish-brown, sunken between the nerves or protruding; teleutospores dark brown, obovate or oblong-clavate, 15–22 by 25–40μ, apex darker, acuminate or obtuse, or with two or more projections, much thickened, 8–12μ, base narrowed, pedicel colored, firm, once to thrice length of the spore, often shorter.

From Massachusetts to Illinois and Nebraska and northward; especially abundant in the upper Mississippi valley. On leaves of the several species of Spartina; the uredospores in July, soon followed by the teleutospores, which persist through the winter and germinate the following spring. Specimens have been examined as follows:

On *Spartina cynosuroides* (L.) Willd. 1881, III, Illinois (1326, *A. B. Seymour*); Sept. 1882, III, Ft. Dodge, Iowa (type of *Urom. acuminatus* Arth., *J. C. Arthur*); Nov. 1882, III, Decorah, Iowa (*E. W. D. Holway*); Dec. 1882, III, Spirit lake, Iowa (*J. C. Arthur*); July 1883, II, Spirit lake, Iowa (*J. C. Arthur*); Sept. 1883, III, Decorah, Iowa (Ellis, N. Am. Fungi, 1443, *E. W. D. Holway*); Dec. 1883, III, Spirit lake, Iowa (*J. C. Arthur*); Aug. 1884, III, Bismarck, N. D. (Journey to Washington Territory, 297, 298, *A. B. Seymour*); Aug. 1884, III, Valley city, N. D. (Journey to Washington

Territory, 299, *A. B. Seymour*); Sept. 1884, III, Decorah, Iowa (*E. W. D. Holway*); Oct. 1885, III, Decorah, Iowa (Sydow's Uredineen, 251, *E. W. D. Holway*); July 1886, II. iii, Emmet co., Iowa (*R. I. Cratty*); Aug. 1886, III, Emmet co., Iowa (524, *R. I. Cratty*); Oct. 1888, III, Racine, Wis. (*J. J. Davis*); Aug. 1898, II. iii, Spirit lake, Iowa (*J. C. Arthur*); April 1899, III, Ames, Iowa (Cryptogams: Plants of Iowa distributed by the Iowa State College, 47, *H. H. Hume*); July 1899, II. III, Fargo, N. D. (*H. L. Bolley*); Aug. 1899, ii. III, Long Pine, Neb. (*J. M. Bates*); Oct. 1901, III, Fargo, N. D. (*H. L. Bolley*); no date, ii. III, Canada (1193, *C. G. Pringle*).

On *Spartina gracilis* Trin. Sept. 1884, III, Medora, N. D. (Journey to Washington Territory, *A. B. Seymour*); July 1901, II. III, Gleichen, Alberta, Can. (*E. W. D. Holway*).

On *Spartina glabra* Muhl. No date, II. III, Woods Hole, Mass. (Ellis' N. Amer. Fungi, 239, type collection of *Urom. Spartinæ* Farl., *W. G. Farlow*); Oct. 1889, III, Cambridge, Mass. (Seymour and Earle's Economic Fungi, 68, *A. B. Seymour*).

On *Spartina patens* (Ait.) Muhl. Oct. 1889, III, Cambridge, Mass. (Seymour and Earle's Econ. Fungi, 67, *A. B. Seymour*); Sept. 1899, ii, III, Portland, Me. (*J. C. Arthur*).

The species apparently finds its greatest development, judging by the abundance of the teleutosporic stage, in the prairie region of the upper Mississippi valley and northward, although, judging by the fullness and prominence of the sori and plumpness of the spores, it flourishes best along the northern Atlantic shores. No one has yet been able to suggest the probable aecidial stage, which should be known before pronouncing upon the conditions best suited to the species. Dr. W. G. Farlow,[3] in notes on the first collection made at the seashore, mentions his failure to find any aecidium in the vicinity that could reasonably be associated with it, and several times in northern Iowa, where the species is especially abundant, the writer has made careful search for a related aecidium, but wholly in vain.

The teleutospores of this species, as well as their sori, are quite variable (*fig. 1, a* to *e*). Collections made from salt marshes near the sea, which have heretofore been called *Urom. Spartinæ* Farl., have the sori prominent, and the teleutospores with more rounded apices, and, in general, a deeper-colored, more luxuriant appearance (*fig. 1, c*). This richer development

[3] Proc. Amer. Acad. Sci. 18: 77.

also extends somewhat to the uredospores, which generally are larger and have thicker walls. But these characteristics are not wholly absent from inland specimens. They are quite as well shown in both sori and spores in two collections from Alberta and North Dakota in the northwest, both on *Spartina gracilis* (*fig. 1, e*), and also, so far as the spores are concerned, in a specimen from Nebraska (Bates, Aug. 1899) and one from Wisconsin (Davis, Oct. 1888), both on *S. cynosuroides* (*fig. 1, b* and *d*). The latter specimen is in the herbarium of Mr. A. B. Seymour,

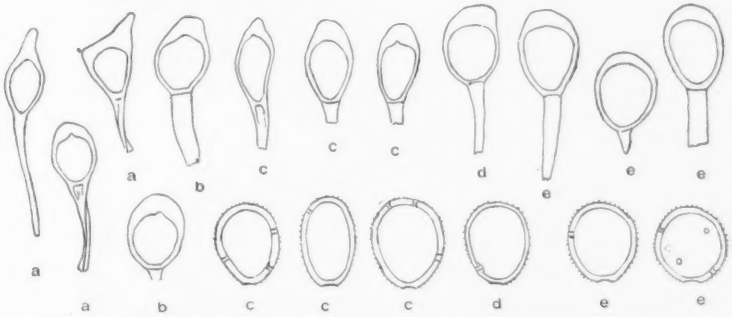

FIG. 1.—*U. acuminatus: a*, three teleutospores showing size and diverse forms common on the western prairies, on *Spartina cynosuroides* from Iowa; *b*, two teleutospores on same host from Wisconsin (Davis, 1888); *c*, three uredospores and three teleutospores of the typical *U. Spartinae* Farl. common along the seashore, on *Spartina glabra* from Woods Hole, Mass.; *d*, one uredospore and one teleutospore on *Spartina cynosuroides* from Nebraska (Bates, Aug. 1899); *e*, two uredospores and three teleutospores on *Spartina gracilis* from Alberta (Holway, 1901).

and is accompanied by the following note, probably made by the collector: "Has the large, blunt-warted uredospores of *Urom. Spartinæ*, but hardly the long and broad pedicels of the teleutospores, nor the large, elongated sori; it has darker and more rounded teleutospores than *Urom. acuminatus*." This note brings out clearly the distinctions that have been maintained between the two forms.

Of the variability of the teleutospores of the inland form Burrill[4] makes the following observations (*fig. 1, a*): "Among

[4] Parasitic fungi of Illinois, Bull. Ill. Lab. Nat. Hist. 2:169.

the Uromycetes inhabiting grasses this is readily distinguished by the irregular and peculiar shape of the teleutospores; while some are no longer than wide, many are oblong or nearly lanceolate, while the apex has a multitude of forms; sometimes straight, sometimes acutely acuminate, often turned sidewise, beak-like, not seldom double, and occasionally suggesting the appendages at the apex of the teleutospores of *Puccinia coronata*." The paler, more slender, and poorly nourished teleutospores of the inland form are associated with the smaller sori, which are sunken and compressed between the stout nerves of the leaves.

If there are specific differences between the seashore and inland forms of this rust, they can only be established with certainty by cultures. Morphological characters derived from the uredo and teleuto stages show no differences that are not accounted for by ecological conditions.

The species was first recorded by Farlow[5] in 1878 under the name *Urom. Junci*. The following year the same collection was distributed in Ellis' *North Amer. Fungi*, No. 239, under the name *Urom. Junci* var. *Spartinæ*, but without description. Later study resulted in raising the form to specific rank, as given in the synonymy above.

2. PUCCINIA FRAXINATA (Lk.), nom. nov.

SYN.: 1822. *Aecidium Fraxini* Schw. Schrift. d. nat. Ges. zu Leipzig 1:66.

1825. *Caeoma Fraxinatum* Link. Linné Sp. Pl. 6²:62.

1834. *Caeoma* (*Roestelia*) *Fraxinites* Schw. Trans. Amer. Phil. Soc. 4:294.

1890. *Uredo peridermiospora* E. & T. Jour. Myc. 6:77.

1896. *Puccinia sparganioides* E & B. Erythea 4:2.

1899. *Puccinia peridermiospora* Arth. Science 10:565.

EXSICC.: Ellis and Everhart, N. Amer. Fungi, 1851^{III}, 3475^{III}.
Ellis and Everhart, Fungi Columb., 1288^{III}.
Carleton, Ured. Amer., 33^{I}.
Sydow, Uredineen, 262^{III}, and 1167^{III}.

O. I. Spermogonia epiphyllous, yellow, inconspicuous;

[5] Bull. Bussey Inst. 2:225 and 243.

spermatia obovate or oblong, about 3 by 5 μ. Aecidia hypophyllous, or on petioles and fruit, in dense rounded groups, usually on swollen and discolored spots; peridia cylindrical, often elongated, margin lacerated; aecidiospores obovate or elliptical, 22–26 by 33–37 μ, contents orange when fresh, becoming faintly yellow when old, wall colorless, thin at the sides but greatly thickened at the obtuse apex, tuberculate.

II. III. Sori hypophyllous, amphigenous on some hosts, supercostal, very prominent, large, oblong, elongated on sheaths and culms, ruptured epidermis attached in shreds or disappearing. II. Uredosori pulverulent, at first bright orange, becoming yellowish and indistinct; uredospores obovate or elliptical, 22–30 by 33–44 μ, contents orange when fresh, becoming faintly yellow when old, wall colorless, thin at the sides but greatly thickened at the rounded apex, prominently tuberculate, pores obscure. III. Teleutosori pulvinate, blackish-brown; teleutospores elliptical or oblong, 16–22 by 35–62 μ, dark brown, slightly constricted at the septum, apex obtuse, thickened; pedicel firm, slender, tinted, once to twice the length of the spore

Common throughout the United States and Canada east of the Rocky mountains. On leaves, petioles, and fruiting inflorescence of the various species of Fraxinus and Spartina; spermogonia and aecidia May to July, uredo in July and August, followed shortly by the teleutospores, which persist through the winter and germinate the next spring. Specimens have been examined as follows:

On *Fraxinus lanceolata* Borck. (*F. viride* Michx.) May 1871, O. I, Ames, Iowa (*J. C. Arthur*); July 1883, O. I, Spirit lake, Iowa (*J. C. Arthur*); 1886, I, Washington, D. C. (collector not recorded); June 1892, O. I, Rockport, Kan. (*E. Bartholomew*); June 1892, I, Manhattan, Kan. (Carleton's Ured. Amer., 33, *M. A. Carleton*); Aug. 1898, I, Heron lake, Minn. (*J. C. Arthur*); May and June 1899, O. I, Lafayette, Ind. (grown from teleutospores on *Spartina* by the writer, *J. C. Arthur*); June 1899, I, Ames, Iowa (*H. H. Hume*); July 1899, I, Spirit lake, Iowa (*J. C. Arthur*); Aug. 1899, I, South Hero, Vt. (*L. R. Jones*); June 1900, O. I, Spirit lake, Iowa (*J. C. Arthur*); July 1901, I, Crow agency, Mont. (237, *J. W. Blankinship*).

On *Fraxinus Americana* L. June 1889, O. I, Iowa city, Iowa (*Mrs. M. F. L. Fitzpatrick*).

On *Fraxinus Pennsylvanica* Marsh. (*F. pubescens* Lam.). June 1899, O. I, Long pine, Neb. (*J. M. Bates*); Aug. 1899, I, South Hero, Vt. (*L. R. Jones*).

On *Fraxinus nigra* Marsh. (*F. sambucifolia* Lam.). July 1884, o. I, La Crosse, Wis. (*L. H. Pammel*).

On *Fraxinus* sp. indet. No date, o. i, Bethlehem, Pa. (Type of *Æcid. Fraxini* Schw., *L. von Schweinitz*).

On *Spartina cynosuroides* (L.) Willd. Aug. 1882. III, Charles city, Iowa (*J. C. Arthur*); Oct. 1882, III, Ames, Iowa (*J. C. Arthur*); Oct. 1882, III, Urbana, Ill. (6335, *A. B. Seymour*); Oct. 1882, III, Ames, Iowa (*J. C. Arthur*); Nov. 1882, III, Decorah, Iowa (*E. W. D. Holway*); Dec. 1883, III, Spirit lake, Iowa (*J. C. Arthur*); Aug. 1884, III, Bismarck, N. D. (Jour. to Wash. Terr., *A. B. Seymour*); Oct. 1885, III, Decorah, Iowa (*E. W. D. Holway*); Oct. 1885, III, Urbana, Ill. (*M. B. Waite*); Oct. 1889, III, Decorah, Iowa (Sydow's Ured., 262, *E. W. D. Holway*); Oct. 1890, III, Racine, Wis. (*J. J. Davis*); Oct. 1892, III, Brookings, S. D. (*David Griffiths*); Oct. 1892, III, Ames, Iowa (*G. W. Carver*); Aug. 1895, ii. III, Rooks co., Kan. (Type of *Puc. sparganioides* E. & E., 1908, *E. Bartholomew*); Aug. 1897, III, Rooks co., Kan. (Ellis and Everhart's Fungi Columb., 1288, *E. Bartholomew*); Oct. 1897, III, Rooks co., Kansas (*E. Bartholomew*); July and Aug. 1898, II. III, Spirit lake, Iowa (*J. C. Arthur*); Oct. 1898, III, Alburgh, Vt. (*W. A. Orton*); April 1899, III, Lincoln, Neb. (in part used by the writer for successful cultures on Fraxinus, *W. T. Horne*); May 1899, III, Fargo, N. D. (*H. L. Bolley*); May 1899, III, Ames, Iowa (in part used by the writer for successful cultures on Fraxinus, *H. H. Hume*); July 1899, II. III, Fargo, N. D. (*H. L. Bolley*); Aug. 1899, II. iii, Ames, Iowa (*H. H. Hume*); Aug. 1899, III, South Hero, Vt. (*L. R. Jones*); Aug. 1899, III, O'Neill, Neb. (*J. M. Bates*); Oct. 1900, III, Orono, Me. (*R. L. Ricker*); No date, III, Stillwater, Okla. (*E. E. Bogue*); No date, III, Ft. Dodge, Iowa (*J. C. Arthur*).

On *Spartina glabra* Muhl. Sept. 1889, II, Ocean springs, Miss. (type of *Uredo peridermiospora* E. & T., *S. M. Tracy*).

On *Spartina polystachya* (Michx.) Willd. Oct. 1886, III, Point a la Hache, La. (Ellis and Everhart's N. Am. Fungi, 1851, *A. B. Langlois*); No date, III, no locality (Ravenel's Fungi Caroliniani, 89, no collector recorded).

On *Spartina patens* (Ait.) Muhl. 1891, III, Salem, N. J. (*A. Commons*); Sept. 1898, III, Madison, Conn. (2067, *T. E. Hazen*).

In many parts of the country, especially in the upper Mississippi valley, this species is one of the most abundant of plant

rusts, both on Spartina and Fraxinus. Bessey[6] records that in 1885 it infested the green ash trees about Lincoln, Neb., to such a degree as to attract the attention of casual passers.

The teleutosporic form is equally common with the aecidial, and is well represented in herbaria, where it has passed under the name of *Puc. Phragmitis* for the most part. It was not until the publication of the result of cultures by the writer[7] about two years ago, that the autonomy of the species was recognized.

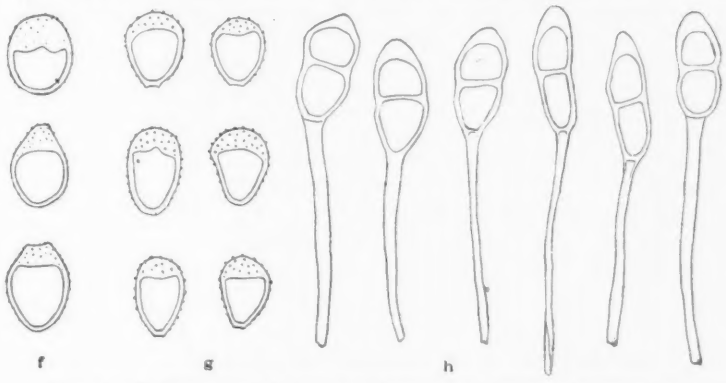

FIG. 2.— *P. Fraxinata: f*, three aecidiospores on *Fraxinus lanceolata; g*, six uredospores, and (*h*) six teleutospores, both on *Spartina cynosuroides.*

The uredo form is very rarely collected, and the writer has had much difficulty to secure material for study. The sori are rather conspicuous when they first appear, but are usually not abundant, and are soon replaced by the teleutospores.

The aecidiospores and uredospores show a very remarkable similarity in color, form, and markings (*fig. 2, f* and *g*). Both have colorless walls, greatly thickened at the apex, and evenly tuberculate. The contents are of the same shade of orange, a color that speedily disappears with the death of the protoplasm. In fact the uredospores differ in appearance from the aecidiospores chiefly in being a little more robust. The shape and dimensions in the diagnosis above are for the spores when seen

[6] Amer. Nat. **19**: 886; see also *ibid.* **20**: 806. [7] BOT. GAZ. **29**: 275.

from the side, that is, in vertical section, making the description of both forms comparable with that of the teleutospores (*fig. 2, h*).

On Spartina this rust occurs exclusively on the hard and smooth surfaces of the plant; the under (smooth) side of the blade, the sheaths, and the exposed parts of the internodes. On *Spartina polystachya* and *S. glabra* it grows equally well on both surfaces of the blade. This difference of habit is correlated with the fact that in these two hosts the hard tissues of the leaf are almost equally well developed upon both sides of the blade, so much so as to prevent the leaf from becoming much convolute upon drying, as it does in the other species of the genus.

The writer is fortunate in having been able to examine all the type material upon which the synonymy of the species is based. The type of *Æcidium Fraxini* Schw., which is in the Schweinitz collection at the Philadelphia Academy of Sciences, consists of a single leaf, bearing thirteen round groups of aecidia. The spots are much swollen, but too young to show open peridia. The type material of *Uredo peridermiospora* Ellis & Tracy consists of the bases of two similar leaves of *Spartina glabra* Muhl., one of which is in the herbarium of Mr. S. M. Tracy, the collector, and the other is in the Ellis herbarium at the New York Botanical Gardens. In the packet at the latter place is the following unsigned note: "Spor. pyriform, 35–45 × 18–22 μ, contents orange-red with a hyaline envelop, which is at first subtubercular-roughened, but finally becomes smooth or nearly so. The spores are much like those of *Peridermium pyriforme* Pk." The type of *Puccinia sparganioides* E. & E. is in the Ellis herbarium at the New York Botanical Gardens. It consists of quite a number of portions of leaves, each about 10^{cm} long, all well covered with uredo- and teleutosori, and is accompanied by diagnostic and other notes. The host was at first supposed to be *Carex sparganioides*, and was so stated in connection with the original description, and hence the specific name; it was afterward thought to be *Carex stricta*, and is so labeled in Ellis and Everhart's N. Amer. Fungi, no. 3475; finally the host was

determined as *Spartina cynosuroides*, and the correction published by Bartholomew[8] in his list of Kansas Uredineae. All the synonyms of the species are founded upon these three types.

The oldest specific name, *Fraxini*, cannot be transferred to the genus Puccinia, as there is already a *P. Fraxini* Kom. from the orient,[9] and the next oldest name, that of Link, is therefore taken.

3. **Puccinia Seymouriana**, sp. nov.

Exsicc: Ellis & Everhart, N. Am. Fungi, 1474 III.
Seymour & Earle, Econ. Fungi, 69 III.

O. I. Spermogonia and aecidia unknown.

II. III. Sori epiphyllous, intercostal, prominent, oblong, ruptured epidermis inconspicuous. II. Uredospores globose, or broadly elliptical, 26–39 by 30–45 μ, contents orange when fresh, becoming faintly yellow when old, at first globose, afterward angular and shrunken, wall colorless, thickened above, sometimes to more than half the diameter of the spore, prominently tuberculate, pores obscure. III. Teleutosori pulvinate, chocolate brown; teleutospores elliptical or oblong, 20–26 by 37–52 μ, slightly constricted at the septum, apex obtuse, thickened; pedicel firm, slender, tinted, once to thrice the length of the spore.

From Massachusetts to Illinois and Iowa, and northward. On blades of *Spartina cynosuroides;* uredospores in July, soon followed by the teleutospores which persist through the winter and germinate the next spring. Specimens have been examined as follows:

On *Spartina cynosuroides* (L.) Willd. July 1881, III, Hudson, Ill. (2348, *A. B. Seymour*); Aug. 1881, III, English prairie, Ill. (1346, *A. B. Seymour*); Oct. 1881, III, Canton, Ill. (1771, *A. B. Seymour*); Oct. 1881, May and Sept. 1882, III, Normal, Ill. (1829, 4794, 6262, *A. B. Seymour*); June 1882, III, Normal, Ill. (5272, *C. A. Hart*); Jan. and March 1883, III, Normal, Ill. (*C. A. Hart*); April 1883, III, Madison, Wis. (*Wm. Trelease*); Oct. 1883, III, Chicago, Ill. (*J. C. Arthur*); Nov. 1883, III, Normal, Ill. (Ellis & Ever-

[8] Trans. Kan. Acad. Sci. **16**: 178.

[9] See Jaczewski, Komarov, Tranzschel, Fungi Rossiae Exsiccati, no. 225, where full description is given.

hart's N. Am. Fungi, 1474, *A. B. Seymour*); Aug. 1884, III, Bismarck, N. D. (Jour. to Wash. Terr., 296, 302, *A. B. Seymour*); Oct. 1890, III, North Weymouth, Mass. (Seymour & Earle's Econ. Fungi, 69, *L. M. Underwood*); Aug. 1896, III, Pt. Abino, Ontario. (*S. M. Tracy*); Sept. 1899, ii. III, Racine, Wis. (type collection, *J. J. Davis*); April 1899, Mar. and April 1900, April 1901, III, Racine, Wis. (*J. J. Davis*); No date, III, Ames, Iowa (*L. H. Pammel.*

In naming this very distinct new species I take pleasure in recognizing the services of Mr. A. B. Seymour in the cause of mycological science. One-third of the collections of this species that I have been enabled to study, coming from various sources, were made by him, and it was during my examination of the material in his private herbarium, kindly placed at my disposal, that I became aware of the existence of the species, which has heretofore been an unrecognized part of the preceding one.

The species is separable from *P. Fraxinata*, and recognizable with considerable ease, by the position of the teleutosporic sori on the rough side of the leaf, emerging from between the nerves. They are usually a little lighter in color also. But the final reliance must be upon the uredospores (*fig. 3, k*), which are very distinctive, and a few of which may almost invariably be found intermixed with the teleutospores (*fig. 3, l*), at whatever season of the year the material may have been gathered. The shrunken contents lying at the base of the spore, and the colorless, tuberculate wall, gives the spores a wholly unique appearance among gramineous species.

Attempts at cultures have been made for three seasons past, but so far in vain. At first the efforts were misdirected from lack of any but the vaguest geographical clues. After detecting and establishing a connection between morphological similarity in uredo and aecidium and also a specific relationship in the preceding species, I searched through the herbarium for some accidiosporic form having colorless, tuberculate walls, and angularly shrunken contents, and was rewarded by finding that *Æcidium Cephalanthi* Seym. possessed exactly these characters. Its geographical range is also that of *P. Seymouriana*, so far as the two are known. In the spring of 1901 I was possessed of

this information and the necessary material, but was frustrated by failure of the teleutospores to germinate. The preceding winter seems, for some unknown reason, to have been destructive of many plant rusts. Not only this species, but *P. Asparagi*, *P. lateripes*, *P. emaculata*, *P. vexans*, and many others could not be made to germinate, showing that the spores had winter-killed. Although cultures must be awaited, yet there can be little doubt that the early stages of *P. Seymouriana* occur upon Cephalanthus.

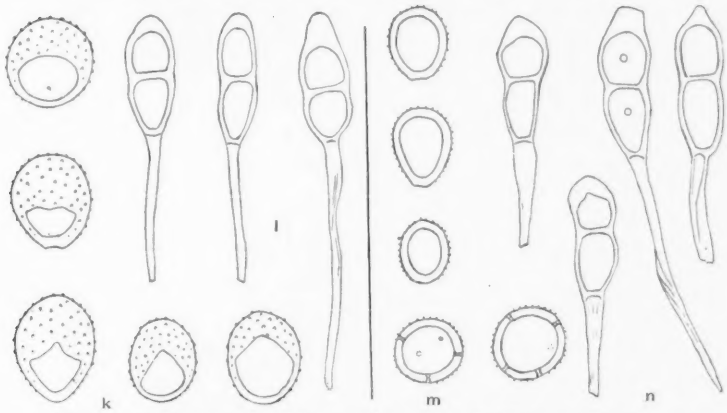

FIG. 3.—*P. Seymouriana: k*, four uredospores, and (*l*) three teleutospores, on *Spartina cynosuroides*. *P. Distichlidis: m*, five uredospores, the two lowermost shown in transverse optical section, and (*n*) four teleutospores, both on *Spartina gracilis*.

4. PUCCINIA DISTICHLIDIS E. & E. 1893. Proc. Phil. Acad. Sci. 1893: 152.

SYN.: 1898. *Dicaeoma Distichlidis* Kuntze. Rev. Gen. Pl. 3: 468.

O. I. Spermogonia and aecidia unknown.

II. III. Sori epiphyllous, intercostal, early naked, ruptured epidermis conspicuous. II. Uredospores broadly elliptical, broadly obovate or globose, 26–32 by 27–40 μ, wall pale yellow, thick, abundantly echinulate with stout points, pores six or more, scattered, indistinct, contents sometimes centrally shrunken. III. Teleutosori blackish, prominent, linear-lanceolate with acute ends; teleutospores obovate or lance-oblong, 17–21 by 48–56 μ,

slightly constricted at the septum, apex obtuse or subacute, thickened, side walls thin, base somewhat narrowed, pedicel firm, rather thick, tinted, as long as the spore or longer.

From Montana to North Dakota and Iowa. On blades of *Spartina;* uredospores in July, soon followed by the teleutospores, which persist through the winter. Specimens have been examined as follows:

On *Spartina gracilis* Trin. Oct. 1888, III, Ten-mile creek, Mont. (*F. W. Anderson*); Oct. 1888, III, Helena, Mont. (185 *F. W. Anderson*); Oct. 1888, III, Helena, Mont. (F. D. Kelsey); Aug. 1890, ii. III, Helena, Mont. (*F. D. Kelsey*); Sept. 1891, III, Helena, Mont. (type collection, *F. D. Kelsey*); Aug. 1901, III, near Laramie, Wyo. (1219, *Elmer D. Merrill* and *E. N. Wilcox*).

On *Spartina cynosuroides* (L.) Willd. Aug. 1884, III, Valley city, N. D. (Journey to Wash. Terr., *A. B. Seymour*); Aug. 1886, III, Emmet co., Iowa (544 *R. I. Cratty*); May 1899, III, Fargo, N. D. (*H. L. Bolley*); July 1899, II. III, Fargo, N. D. (*H. L. Bolley*).

This species was described some time ago, but its true character and position have remained unrecognized, on account of error in determination of the host, which was said to be *Distichlis maritima*, and hence the specific name. The unfortunate mistake has led to much confusion, as many collections on Distichlis have been given this name by wrong assumption, and many unwise comparisons made.

The type is in the Ellis collection at the New York Botanical Garden. It consists of several portions of leaves, each about 8^{cm} long, well covered with teleutosori. It was gathered September 21, 1891, at Helena, Mont., by Rev. F. D. Kelsey. In the herbarium of Mr. A. B. Seymour are two other collections from the type locality, and in the herbarium of Dr. W. G. Farlow is a fourth collection from the same locality. A comparison of these several collections, one (Anderson's No. 185) being accompanied with inflorescence, leaves not the shadow of a doubt that the host for all of them is *Spartina gracilis* Trin. There is, however, a *Puccinia subnitens* Diet., a wholly distinct species, which does occur upon *Distichlis maritima.*

The pointed extremities of the teleutosori, and the large

echinulate uredospores, with uncontracted or occasionally centrally contracted contents, well distinguish this species from other Spartina rusts (*fig. 3*, *m* and *n*).

5. PUCCINIA RUBELLA (Pers.), nom nov.

SYN.: 1791. *Aecidium rubellum* Pers. Linné Syst. Nat. cur. Gmelin 2 : 1473.

1796. *Aecidium Rumicis* Hoffm. Bot. Taschenb. 2 : —.

1803. *Uredo Phragmitis* Schum. Fl. Saell. 2 : 231.

1808. *Puccinia arundinacea* Hedw. Lam. and DC., Encycl. 8 : 250.

1810. *Uredo striola* Strauss. Wetter. Annal. 2 : 105.

1827. *Uredo rubella* Spreng. in part. Syst. Veg. 4 : 572.

1876. *Puccinia Phragmitis* Körn. Hedw. 15 : 179.

1898. *Dicaeoma Phragmitis* Kuntze. Rev. Gen. Pl. 3 : 470.

EXSICC.: Sydow, Ured., 278[I], 576[III], 679[I], 680[I], 779[I], 924[I].
Seymour and Earle, Econ. Fungi, 70[III].
Carleton, Ured. Amer. 36[III].
Eriksson, Fungi Par. Scand. Exsicc., 169[I].
Linhart, Fungi Hungar., 26[II III], 37[I].
Vize, Fungi Brit., 124[III], 161[I].
Thuemen, Myc. univ., 630[I].

O. I. Spermogonia not observed. Aecidia small, hypophyllous, on purple-red, somewhat swollen spots, in rounded, often circinating groups, peridia white, low, with reflexed, much split border, aecidiospores polygonal, 17–25 μ in diameter, nearly colorless, wall rather thin, finely tuberculate.

II. III. Sori amphigenous, prominent, oblong, elongated on sheaths and stems, ruptured epidermis inconspicuous. II. Uredosori, brownish-yellow, pulverulent, without paraphyses; uredospores elliptical or obovate, 19–24 by 27–36 μ, wall thick, golden yellow, tuberculate, pores four, equatorial. III. Teleutosori very prominent, blackish-brown; teleutospores oblong, rounded or obtuse at both ends, slightly constricted at the septum, 18–24 by 45–64 μ, side walls rather thick, apex a little thickened, pedicel firm, slender, strongly tinted, very long, two to five times the length of the spore.

The northern United States east of the Rocky mountains, and Europe. Early stages on several species of Rumex, not yet collected in America, but cultivated from American teleuto-

spores, and also on Rheum ; later stages on Phragmites. Besides many European specimens the following from America have been examined:

On *Rumex crispus* L. May, 1899, I, Lafayette, Ind. (cultivated by the writer from teleutospores sent from Wisconsin and Nebraska.)

On *Rumex obtusifolius* L. May, 1899, I, Lafayette, Ind. (cultivated by the writer from teleutospores sent from Wisconsin and Nebraska.)

On *Rheum Rhaponticum* L. June, 1901, Kearney, Neb. (1822, *J. M. Bates*).

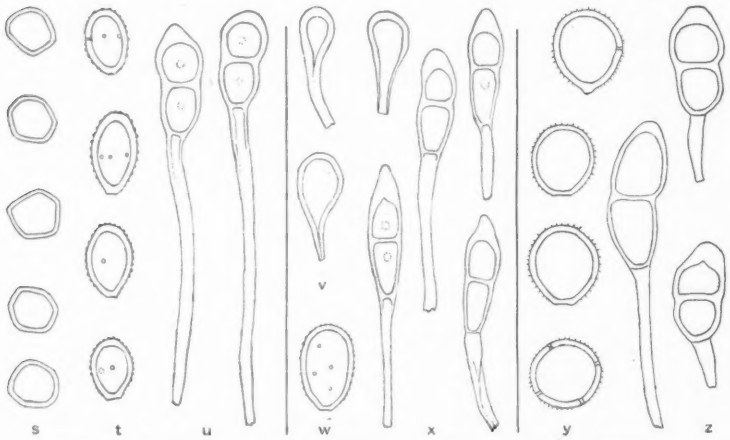

FIG. 4.—*P. rubella: s*, five aecidiospores on *Rumex obtusifolius*, cultivated; *t*, four uredospores, and (*u*) two teleutospores, both on Phragmites. *P. simillima: v*, three paraphyses from uredosori; *w*, one uredospore; *x*, four teleutospores, all on Phragmites. *P. Arundinariae: y*, four uredospores, the lowermost in transverse section; *z*, three teleutospores, both on Arundinaria.

On *Phragmites Phragmites* (L.) Karst. (*P. communis* Trin.) Aug. 1881, III, McHenry, Ill. (1325, *A. B. Seymour*); Aug. 1881, III, Elgin, Ill. (1368, *A. B. Seymour*); Oct. 1884, III, Mason city, Ia. (*E. W. D. Holway*); Oct. 1885, III, Decorah, Ia. (*E. W. D. Holway*); July, 1886, II. III, Vermilion lake, Minn. (137, *E. W. D. Holway*); Oct. 1892, III, Coolidge, Kan. (Carleton's Ured. Amer., 36, *M. A. Carleton*); Nov. 1893, III, Wilmington, Del. (*A. Commons*); Apr. 1899, III, Racine, Wis. (partly used by the writer for successful cultures on Rumex, *J. J. Davis*); May, 1899, III, Lincoln, Neb. (partly used by the writer for successful cultures on Rumex, *C. E. Bessey*); 1901, III, Callaway, Neb. (1658, *J. M. Bates*).

This cosmopolitan species shows no American peculiarities (*fig. 4, s, t,* and *u*) except the great rarity of the aecidial form. The teleutospores, however, are strongly viable, and grow readily on *Rumex crispus* and *R. obtusifolius*, forming normal aecidia exactly like those collected in the open in Europe.[10] The aecidia, which are small, colorless, and inconspicuous, have so far only been found once with certainty in America.

The reasons for selecting the name here adopted should probably be stated. There is no question but that Persoon's *Æcidium rubellum* included the aecidial form of this species of Puccinia, and that it is the oldest name. His diagnosis ran as follows: "*Ae. rubrum. α rumicis, thecis congestis seminibusque albis. β grossulariæ, thecis sparcis seminibusque pallidis.*" The name might evidently have been written *P. Rumicis*, had that name not already been applied elsewhere. In writing *P. rubella* it is assumed that, when all the forms composing a species are serially separated, as indicated by letters or otherwise, the specific name covers the first of these varieties, whether this first variety is given a distinctive name or not. If in such a case the varieties are erected into species, the first one may bear either the specific or the first varietal name.

6. **Puccinia simillima,** sp. nov.

Exsicc.: Sydow, Ured., 274 III in part.

O. I. Spermogonia and æcidia uncertain.

II. III. Sori amphigenous, low and rather small, oblong, elongated on sheaths, ruptured epidermis somewhat noticeable. II. Uredosori light yellow, pulverulent, with clavate paraphyses; uredospores obovate or oblong-clavate, 18–22 by 26–44 μ, wall of medium thickness, golden yellow, minutely tuberculate and sometimes slightly echinulate, pores indistinct, scattered, number undetermined. III. Teleutosori small, very numerous, nearly or quite black; teleutospores at first arising from the uredosori, linear-oblong or oblong-lanceolate, very little constricted at the septum, 15–20 by 42–56 μ, base narrowed, side walls thin, apex acuminate, acute or less often obtuse, thick-

[10] ARTHUR, BOT. GAZ. 18: 269–270. Ap 1900.

ened up to 15 μ, pedicel firm, thick, the length of the spore more or less.

Iowa and Wisconsin. On blades and sheaths of Phragmites; uredospores in July, soon followed by teleutospores, which persist through the winter. Specimens have been examined as follows:

On *Phragmites Phragmites* (L.) Karst. (*P. communis* Trin.) Dec. 1883, III, Spirit lake, Ia. (*J. C. Arthur*); Oct. 1884, III, Mason city, Ia. (*E. W. D. Holway*); Oct. 1885, III, Decorah, Ia. (Sydow's Uredineen, 274, *E. W. D. Holway*); Sept. 1892, III, Ames, Ia. (*G. W. Carver*); Aug. 1898, II. iii, Spirit lake, Ia. (type, *J. C. Arthur*); May 1899, III, Armstrong, Ia. (*R. I. Cratty*); Sept. 1901, III, Racine, Wis. (*J. J. Davis*).

This species probably has a wider distribution than the above series of specimens indicate, as it is likely to have been overlooked. It occurs frequently intermixed upon the same leaves with *P. rubella*. This was the case with all the above collections, except those from northwestern Iowa, at Spirit lake and Armstrong.

Cultures have not yet been made, but there are the strongest reasons, based upon field observations, for believing that the aecidial stage occurs upon *Anemone Canadensis* L. (*A. Pennsylvanica* L.).

The species is very closely related to *P. Magnusiana* Körn.; and even the supposed aecidial stage on Anemone resembles the aecidial form of that species on *Ranunculus repens* and *R. bulbosus*. It is distinguished, however, by the slender, pointed teleutospores, and by the more clavate and less roughened uredospores, and probably by the aecidial host (*fig. 4*, *w* and *x*).

7. PUCCINIA ARUNDINARIAE Schw. 1822. Schrift. d. Nat. Ges. zu Leipzig 1:72.

SYN.: 1898. *Dicaeoma Arundinariae* Kuntze. Rev. Gen. Pl. 3:467.

O. I. Spermogonia and aecidia unknown.

II. III. Sori hypophyllous, rather small, nearly round, early naked, ruptured epidermis inconspicuous. II. Uredosori cinnamon-brown, pulverulent, without paraphyses; uredospores large, broadly elliptical or globose, 24–32 μ in diameter, wall

rather thin, brownish-yellow, sparingly echinulate with stout points, pores indistinct, apparently four and equatorial. III. Teleutosori pulvinate, solid, blackish brown; teleutospores dark brown, linear-oblong, 20–24 by 48–72 μ, not constricted at the septum, side walls moderately thick, apex somewhat thickened, obtuse or rounded, pedicel slender, firm, slightly tinted or colorless, as long as the spore, more or less.

In the southern states from North Carolina to Alabama, not common. On leaves of Arundinaria. Specimens have been examined as follows:

On *Arundinaria tecta* (Walt.) Muhl. No date, III, Salem, N. C. (type, *L. Von Schweinitz*); Feb. 1896, III, Auburn, Ala. (*F. S. Earle* and *L. M. Underwood*); Sept., 1897, III, Tuskegee, Ala. (95, *G. W. Carver*); Sept. 1899, II, iii, Clemson College, S. C. (54, *P. H. Rolfs*); Dec. 1900, III, Clemson College, S. C. (*P. H. Rolfs*).

This is not an abundant species. Although collected by L. von Schweinitz in North Carolina about 1820, and again later in Philadelphia, Penn.,[11] on plants in the Bartram Gardens, brought from a distance, yet it has been rarely collected since. It appears to occur over a wide area, but at all times very sparingly. The uredo stage, being light brown in color, is especially difficult to find. I am indebted to Mr. P. H. Rolfs and Mr. George W. Carver for material for study, which they obtained for me after much search.

The type specimen in the herbarium of the Philadelphia Academy of Sciences consists of a single fragment of leaf about 8 by 50 mm, bearing only three sori. Both host and fungus fall somewhat short of perfect development.

A single glance at the uredospores of this species (*fig. 4, y*) shows that it could be associated with *P. rubella* (*P. Phragmitis*) only through ignorance of its real characteristics. The usually elongated, non-constricted, and often curved teleutospores are also distinctive (*fig. 4, z*).

This completes the list of species known to occur on Spartina, Phragmites, and Arundinaria in North America. There are only

[11] Trans. Amer. Phil. Soc. 4: 295.

two records[12] of any Uredineae being found on these hosts in South America, both given as *P. Phragmitis*, which I have had no opportunity to verify; and there is no record of such occurrence in Central America, Mexico, or the West Indies.

The parasitism of the Uredineae is so intimate that, when it is noticed that the three genera of hosts here studied belong to three widely separated sections of Gramineae, strong proof should have been required to show that any one species of rust could inhabit them all. In determining unnamed material the following key, based upon distinctions of host, position on the host, and the uredospores may prove serviceable. It is rare that some search in almost any specimen, at whatever time of year it may be gathered, does not disclose at least a few uredospores. The teleutospores are not so distinctive.

CHLORIDEÆ: *Spartina.*
- Sori arising from soft tissues (intercostal),
  - Uredospores with wall thin, colored, echinulate - *U. acuminatus.*
  - Uredospores with wall thick, pale, echinulate - - *P. Distichlidis.*
  - Uredospores with wall thickened above, colorless, tuberculate - - - - - - - - *P. Seymouriana.*
- Sori arising from hard tissues (supercostal),
  - Uredospores with wall thickened above, colorless, tuberculate - - - - - - - - *P. Fraxinata.*

FESTUCEÆ: *Phragmites.*
- Sori amphigenous, uredosori without paraphyses,
  - Uredospores with four equatorial pores - - - *P. rubella.*
- Sori amphigenous, uredosori with paraphyses,
  - Uredospores with indefinite, scattered pores - - *P. simillima.*

BAMBUSEÆ: *Arundinaria.*
- Sori hypophyllous, uredosori without paraphyses,
  - Uredospores with rather thick wall, echinulate - *P. Arundinariae.*

The four species on Spartina will shortly be published as exsiccati in the fourth fascicle of Arthur and Holways's *Uredineae Exsiccatae;* and the two species on Phragmites will be published somewhat later in the fifth fascicle of the same series.

PURDUE UNIVERSITY,
Lafayette, Indiana.

[12] Hedwigia **35**: 288. 1896. SPEGAZZINI's Fungi Arg. 1221. 1899. Both reported on Phragmites from Argentine.

CONTRIBUTIONS FROM THE ROCKY MOUNTAIN HERBARIUM. III.

AVEN NELSON.

STUDIES IN ERIOGONUM.

THIS genus is remarkably well represented in Wyoming. Since most of the species in it are peculiar to arid America, any of the states with desert areas may be expected to represent a considerable number of the increasingly long list of species. A line drawn from central Wyoming to western Arizona will divide into somewhat equal parts the Eriogonum belt.

No recent revision of the genus has been published, but a considerable number of new species have appeared. When one considers how extensively collections have been made in the arid west indicated above, it seems rather remarkable that Dr. Watson's revision of twenty-five years ago (Proc. Am. Acad. 12 : 254) should so nearly represent our knowledge of these plants as it does. That a revision is now needed I think all will admit, but until some one finds time and occasion to do so, notes upon and additions to the species may not be out of place.

Eriogonum orendense, n. sp.— Caudex woody, almost wholly subterranean, its numerous branches densely tufted : tomentum rather dense, uniform throughout the plant, giving it a greenish-white hue : stems numerous, crowded, very short, exclusive of the woody persistent base not to exceed 5 cm : leaves numerous, crowded, narrowly oblong or oblanceolate, subacute, 1–3 cm long, tapering into a slender petiole which usually exceeds the blade : scapes erect, 7–15 cm long, surpassing the leaves : inflorescence umbellate, with short subulate bracts ; the rays unequal, 1–2 cm long, terminating in a few-flowered cyme (3–7), with very short connate bractlets : involucres short-peduncled (1–3) mm, turbinate, merely toothed around the summit, about 3 mm long, many-flowered (8–12) : calyx bright yellow ; the segments

similar, scarcely 2 mm long, oblong, obtuse, the slender pedicels intermingled with setae bearing stipitate glands and a few fine slender hairs: filaments linear, sparsely pubescent to above the middle: styles slender, long exserted: ovary glabrous; mature akene not seen.

Probably most nearly allied to *E. campanulatum* Nutt., though very different from that and blossoming much earlier in the season. The proposed species was found in full bloom June 11, 1900, on the stony slopes of Orendo butte, in the Red desert. This is very early in the growing season in this range. *E. campanulatum*, in this same range, blossoms late in the season, and is a much larger plant, with a compound inflorescence as well as a number of minor floral differences. The type no. is 7143, collected as above.

ERIOGONUM OVALIFOLIUM Nutt.—There is perhaps no species in the genus more variable as to color of flowers than this, if the specimens as named in the herbaria are to be considered the only evidence. Nuttall originally distinguished two species in the present aggregate and consistently maintained them both. *E. ovalifolium* was applied to the form with "bright sulphur-yellow" perianth, which occurs in greater or less abundance on the arid table-lands about the "sources of the Missouri." Of the allied forms, however, this was the less abundant, so that by this time the mention of *E. ovalifolium* suggests not the original, but the *E. purpureum* of Nuttall. That this is the case is easily verified by referring to Jour. Acad. Philad. **7**: 50, and to Jour. Acad. Philad. new ser. **1**: 166, in the latter of which these two species appear under the there proposed genus *Encycla*.

Whether the two can be maintained as distinct species may well be questioned, but there are the best of reasons for retaining the later one as a variety. Not the color of the perianth alone, though in regions in which both grow I have seen nothing to indicate that they intergrade, but the differences (though slight) as given in the publications cited indicate at least varietal rank, as suggested in DC. Prod. **14**: 10. Accordingly the white-flowered form, which almost constantly shows traces of purple or may even become of a deep purple hue (never yellowish?), may be designated

ERIOGONUM OVALIFOLIUM **purpureum**, n. comb.—*Encycla purpurea* Nutt. Jour. Acad. Philad. new ser. **1**: 166; DC. Prod. *l. c.*

ERIOGONUM CRASSIFOLIUM Benth. Trans. Soc. Linn. Lond. 17: 408; Hook. Fl. Bor.-Am. *pl. 176*. *E. aureum* Nutt. in. DC. Prod. **14**: 8.—This excellent species has for a long time been wholly in eclipse, or at most has been accorded only varietal rank. It is most abundant in the type locality, "Scopulosis ad regionem super. fl. Platte." It has several times been collected by the writer and distributed as a variety of *E. flavum* Nutt. Again collected in 1900 as no. 7285 in quantity, and will be distributed as a species, which it properly is.

ERIOGONUM CRASSIFOLIUM **tectum**, n. var.—Densely tufted with deep set woody roots, the crowns of the branched caudex inordinately enlarged by the thick, closely sheathing, very woolly leaf bases: leaves all crowded on the short crown, firm and thick, densely tomentose, ovate to oval or more rarely oblong, 2–3^{cm} long, on very short petioles (¼ to ½ as long): scapes stout, about 1^{dm} long: flower yellow, but the yellow obscured by the long, dense, tomentose pubescence of the involucres and calyx-segments: inflorescence subcapitate, the rays mostly shorter than the foliar bracts.

The variety may readily be known by the remarkable protection against desiccation and cold that is afforded the crowns of the caudex, and the whole plant for that matter, by the dense tomentum. That is a character of the species, but in a small degree when compared with the variety. The shorter petioles and rays and the thick, leathery leaves further distinguish it. The species comes into blossom in June, while the variety in the same range not till August. Only one no. of the variety is at hand, 2041, Sand creek, Albany co., Aug. 8, 1896, on dry, sandy, eroded banks.

Eriogonum fruticosum, n. n.—*E. aureum* Jones, Contrib. to W. Bot. **7**: 718; not *E. aureum* Nutt. DC. Prod. **14**: 8.

ERIOGONUM FRUTICOSUM **ambiguum**, n. comb.—*E. aureum ambiguum* Jones, Contrib. to W. Bot. **7**: 719.

ERIOGONUM FRUTICOSUM **glutinosum**, n. comb.—*E. aureum glutinosum* Jones, Contrib. to W. Bot. **7**: 719.

Eriogonum laxifolium.—*E. Kingii laxifolium* T. & G. Proc. Am Acad. **8**: 165; *E. chrysocephalum* Gray, Proc. Am. Acad. **11**: 101

Malvastrum dissectum, n. comb. — *Sida dissecta* Nutt., Torr. & Gray, Fl. 1:235; not *Malvastrum coccineum* Gray, Pl. Fendl. 24; Gray, Pl. Wright. 1:17; nor *M. dissectum* Cockerell, Bull. Torr. Bot. Club 27:87. — Perennial: many-stemmed from a multicipital caudex, 2^{dm} high or less, densely cinerously stellate-pubescent, the stems whitened with the closely appressed hairs, the calyx obscurely glandular beneath the pubescence: leaves small, $1–3^{cm}$ broad, pedately 3–5-parted, the divisions incisely lobed, the lobes narrowly oblong to linear: racemes several-flowered, pedicels $2–5^{mm}$ long; flowers scarlet: the petals obovate, nearly truncate and merely emarginate; the stigmas capitellate.

That Nuttall was justified in separating this from *M. coccineum* seems perfectly evident to any one who has seen both species in their native habitat. It is at once distinguished from *M. coccineum* (Nutt.) Gray by its cinereous white aspect, by its smaller and more narrowly lobed leaves, and narrower petals. There can be no question which species Nuttall meant to designate *Sida dissecta,* when one reads the notes and descriptions relating to these two species in *Fl. N. Am.* The *Cristaria coccinea* Pursh, Fl. 2:453, *Malva coccinea* Nutt. Gen. 2:81, and *Sida coccinea* T. & G. Fl. 235, undoubtedly refer to the same plant, viz., the broad-leaved form so common on the great plains between the Rocky mountains and the Missouri river. *Sida dissecta* of the T. & G. *Flora* is clearly the plant still found on the high saline desert table-lands, "sources of the Platte near the Rocky mountains." Were more evidence needed to show that *S. dissecta* designates the more western plant, it is found in the fact that the *Sida dissecta* Hook. and Arn. Bot. Beechy, Suppl. 326, is considered by Torrey and Gray (Fl. N. A. 682) as identical with the Nuttallian plant.

On the other hand, Dr. Gray did not consider the plants of *Pl. Fendl.* and *Pl. Wright.* as identical. In the former he uses this expression " * * a few specimens of the var. *dissecta,* or of forms that evidently connect the *Sida dissecta* of Nuttall with *S. coccinea.*" In the latter, the language is " * * a more canescent variety, * * approaching the var. *dissectum.*"

These southern narrow-leaved forms, nicely distinguished from *Malvastrum coccineum* by Professor Cockerell, are far enough from the Nuttallian *dissectum.* They may therefore be designated —

Malvastrum Cockerelli, n. n. — *M. dissectum* (Nutt.) Cocker-

ell, Bull. Torr. Bot. Club **27**:87. *M. coccineum dissectum* Gray, Pl. Fendl. 24; and Pl. Wright. **1**:17.

Malvastrum elatum. — *M. coccineum elatum* E. G. Baker, Jour. Bot. **29**: 171. — This plant, originally published as a variety, is so different from the true *M. coccineum* that it is less confusing to consider it a species. It is not only much larger, with broader leaf-segments, but its more erect habit and tendency to paniculate branching give it the aspect of a Sphaeralcea. Its pubescence is less conspicuous, and the carpels not so evidently reticulate-veined, and the sepals shorter and more abruptly acute. It occurs very sparingly. I have twice collected it, both times at Evanston, Wyoming.

CERASUS DEMISSA **melanocarpa,** n. var. — Varying from a small shrub to a tree-like one, 4–5^{m} high: leaves smooth or nearly so on both sides, the teeth of the fine serration incurved or appressed; petioles not glandular: raceme of white flowers compact, erect or ascending: fruit when fully mature black.

The Rocky mountain form of *Cerasus demissa* is clearly, at least varietally, distinct from the original Nuttallian specimens. Nuttall's specimens from "The plains of the Oregon towards the sea, and at the mouth of the Wahlamet," differ from the more eastern form in the pubescent leaves which are serrate with straight teeth and with glandular petioles; more evidently yet in the red fruits which are sweeter and less astringent than the black ones.

The variety proposed is in many respects intermediate between typical *Cerasus virginiana* of the eastern states and typical *C. demissa* of the far west. All the Rocky mountain specimens seen by me are of this variety.

GENTIANA BRACTEOSA Greene. — In publishing this species (Pitt. **4**:180) Professor Greene lays stress upon the narrowness of the leaves, but I am satisfied that this character will not distinguish it from *G. Parryi.* Some fine specimens collected by Mr. H. N. Wheeler, Camp Albion, Colorado, Aug. 30, 1901, have the floral characters of *G. bracteosa*, but typical leaves of *G. Parryi.* Furthermore, in some specimens of *G. Parryi* the stems in the same clump vary as to the leaves from narrowly oblong to broadly ovate. The species I think will stand, however, on the bract characters, and a peculiarity of the spathaceous cleft calyx not pointed out by Dr. Greene. The calyx-tube

is membranous at summit, and its oblong or elliptic short green teeth are seemingly not a continuation of the tube, but are inserted below the margin, on the outside, and often scarcely exceeding its membranous rim. Unless these characters are distinguishing, it will have to take varietal rank.

Gentiana strictiflora (Rydb.).— *G. acuta strictiflora* Rydb. Mem. N. Y. Bot. Gard. 1 : 309. 1900; full citation given in the same place. — This well deserves specific rank. It has quite as good characters as the allied species *G. acuta*, *G. tenella*, and *G. heterosepala*. Its large size, strict habit, numerous flowers, and the distinctly ochroleucous corollas are wholly characteristic. Common in moist swales on bottom lands.

GENTIANA CALYCOSA **xantha**, n. var. — Habit of the species, smaller, 1 dm or less high : leaves about five pairs, longer than the internodes; the single flower smaller, yellow or yellowish-white with numerous green dots.

At first sight these plants strike one as a decided novelty, but closer examination reveals no decisive character except the color. Even the conspicuous green dots in the corolla are not wanting in the species itself, though much obscured by the deep blue of that.

Collected by Elmer D. Merrill and E. N. Wilcox, on the Tetons, above Leigh's lake, Wyoming, July 26, 1901; no. 1108.

Phacelia corrugata, n. sp.— Biennial or more enduring, 3–5 dm high, slightly glutinous and more glandular-pubescent: stem either branched or simple at base, the branches also sparingly branched, moderately leafy, terminating in elongated naked peduncles: leaves narrowly oblong in outline, somewhat alternately 11–15-lobed, the broad sinuses extending about half way to the midrib, each lobe with two to four rounded unequal lobules; petioles short or wanting : spikes very dense even in fruit, rather tardily open; pedicels very short (1 mm): sepals linear-oblanceolate, sparsely hirsute, nearly as long as the corolla : corolla blue, campanulate-fünnelform, 1 cm or more long, as much in diameter over the limb, lobes suborbicular, internal folds short and united around the base of the filament : stamens and styles nearly twice the length of the corolla; the undivided base of the style pubescent : capsule elliptical, about 5 mm long : the seed oblong,

obtuse at both ends, deeply excavated on the ventral side, the inner side of the lateral angles and one side of the salient central ridge strikingly corrugated by rounded, pitted papillae, minutely ridged-papillate on the base.

This has passed for a form of *P. crenulata* Torr., a plant which I think is found only much farther west. That differs from the plant here described in the smaller size, more deeply lobed leaves, more open spikes, rotate-campanulate, violet corolla, with broad internal folds; the short, linear calyx-lobes; the globular capsule and reticulated, much smaller seeds.

I base the species on specimens from Colorado as follows: no. 2129 (type), G. E. Osterhout, Rifle, Garfield co., June 23, 1900, in mature fruit; (co-type) C. S. Crandall, Palisades, Mesa co., May 14, 1898, in full bloom.

Gilia Merrillii, n. sp.—Perennial, from a short woody caudex and tap root: stems few to many from the crown, erect or spreading, sparsely woolly-pubescent, 10–15 cm long, very leafy towards the base: leaves all simple, crowded, glabrous or nearly so, linear-subulate, cuspidate, either appressed or spreading: flowers white, closely capitate, the heads large (10–20 mm in diameter): calyx lobes subulate, with a green midrib, a little shorter than the scarious tube: corolla tube 4–6 mm long, exceeding the calyx lobes, its oval lobes noticeably shorter than the tube: stamens exserted, the filaments a little shorter than the corolla lobes: capsule broadly oval, longer than the calyx tube, its cells 1-seeded.

In habit this species suggests *G. congesta* or *G. iberidifolia,* but the numerous short, simple leaves are wholly distinguishing even without the other characters. I name it for Mr. Elmer D. Merrill, who, in company with Mr. E. N. Wilcox, made an extensive and valuable collection in western Wyoming and eastern Idaho, in the summer of 1901. It was secured on dry soil, fifteen miles south of Leckie, Wyoming, June 15; no. 746.

Gilia Wilcoxii, n. sp.—Annual, 1–3 dm high, generally branched from the base; the branches in turn sparsely branched, erect or (if several) decumbent at base, somewhat floccose woolly, tardily glabrate: leaves less woolly than the stems, alternate, 2–5 cm long, pinnate; the segments narrowly linear, mucronate, the lateral ones widely divaricate, short (mostly less than 1 cm), usually two pairs: flowers in small bracteate clusters

terminating the branchlets, involved in wool especially the base of the calyx and the subtending green foliar bracts; bracts pinnately 3-cleft, the terminal lobe surpassing the calyx: sepals 5, green, equal or nearly so, pungently mucronate, hardly united except by the enveloping wool, about 7 mm long: corolla light blue, tubular, dilating into a broader throat, tube surpassing the calyx, lobes oblong, obtuse, about half as long as the tube: stamens scarcely exserted (the anthers only in the sinuses of the corolla lobes): ovules about four to each cell, not all maturing: seeds small, rhombic in outline, obscurely scarious on the angles and the tips, apparently not developing mucilage when wetted.

This is a close ally of *G. floccosa* Gray, which is a plant of Oregon, extending southwest into California. In this species it may be noted that the leaves are usually simple, the calyx of four unequal lobes, the corolla tube yellow, the anthers exserted, the seeds fewer, larger, not angled, developing copious mucilage.

Following Bentham, Mr. Howell in his *Fl. N. W. Am.* restores to generic rank the section HUGELIA and places in it *G. floccosa*. If that genus is to stand, the species now proposed must find its way into it, but I am unable to see any valid generic characters.

Named for Mr. Wilcox, mentioned above, who with Mr. Merrill secured three collections of it, all near St. Anthony, Idaho, in July 1901; nos. 822, 862, and 952.

Lappula columbiana, n. sp.— Annual, 3–5 dm high, hirsute with soft white hairs, those on the leaves with pustulate base: stem simple below, upward freely and divaricately branched; the branches tapering, long and slender, sparsely fruited: leaves from linear-spatulate (below) to linear, passing into the bracts which exceed the short pedicels: sepals nearly linear, 5–6 mm long, surpassing the fruit: corolla small, mostly light blue: nutlets similar, prickles few (7–9), united below into a shallow, involute-margined cup, finely and closely muricate ventrally, the murications on the dorsal face (disk) in about three rows, those of the middle row largest.

This is the *L. texana* of the *Flora of the Palouse Region* by Piper and Beattie; *Fl. N. W. Am.* Howell in part at least; not *L. texana* (Scheele) Britt. The latter is indeed Texan and not well known. Neither may it be considered *L. cupulata* (Gray) Rydb. (See Bull. Torr. Bot. Club **28**: 31). Now

that the old and troublesome aggregate has been broken up, there is no way left except to constitute this a species. Its range seems to be in the region of the tributaries of the Columbia. Three collections are represented before me: no. 1703, C. V. Piper, Alamota, Wash.; A. A. & E. Gertrude Heller, Nez Perces co., Idaho; L. F. Henderson, Lewiston, Idaho.

Lappula cucullata, n. sp. — Sparingly cinereous-pubescent throughout: tap-root slender: several to many-stemmed from the crown, the stems simple or sparingly branched, only 1–2 dm high: leaves numerous, small, narrowly oblong, 1–3 cm long, passing into the small foliar bracts: nutlets similar, and all deeply cupulate or hooded, the border of the hood thin and strongly involute, the rounded margin bearing a few short glochidiate prickles, the tip of the nutlet with nearly an equal number of slender prickles not involved in the border of the hood (these characters not fully developed till maturity); the body of the nutlet with a dorsal slightly muriculate ridge, ventrally orbicular with an abrupt acumination, strongly keeled, the sides closely muriculate.

This has possibly its nearest ally in *L. heterosperma* Greene, but is somewhat differently branched, is less cinereous, and has the nutlets all alike.

The type number is 7250, Fort Steele, Carbon co., Wyo. Dry, sandy slopes.

LAPPULA HETEROSPERMA **homosperma,** n. var. — Larger than the species, paniculately branched from the base upward: nutlets all similar and with the characters of the cupulate ones of the species.

Specimens of the variety by Mr. G. E. Osterhout, New Windsor, Colo., June 23, 1899.

Cryptanthe depressa, n. sp. — A small depressed annual, freely and divaricately branched, 3–6 cm high and more widely spreading, the dense pubescence soft-hispid, white with a slight fulvousness in the inflorescence: leaves small, linear, 10–15 mm long: flowers minute: sepals linear, shorter than the corolla: corolla 2 mm long, its lobes less than half the length of the slender tube: anthers below the middle of the tube: nutlets ovate, acute, smooth, the linear scar nearly closed and forked at the base, more than 1 mm long.

It has the aspect of some of the species of the deserts of the southwestern United States, but I am unable to find a close ally.

Collected by Messrs. E. D. Merrill and E. N. Wilcox, dry soil, seven miles west of St. Anthony, Idaho, July 8, 1891; no. 873.

Cryptanthe Howellii, n. n.— *C. multicaulis* Howell, Fl. N. W. Am. 487; not *C. multicaulis* Aven Nelson, Bot. Gaz. **30**: 194.— This species may appropriately be named for its discoverer and describer, the indefatigable student of our northwestern plants, Mr. Thomas Howell.

Oreocarya cana, n. sp.—The multicipital caudex tufted, its branches clothed at their summits with the densely pubescent leaf bases: stems single from the crowns, 1–2^{dm} high, simple, softly and closely pubescent: leaves silvery white with a short, close, soft pubescence; the numerous crown leaves linear-oblanceolate, 3–7^{cm} long, scarcely petioled; stem leaves shorter, sessile above: inflorescence a short dense thyrsoid spike, its pubescence moderately dense and slightly fulvous (scarcely hispid): sepals linear, 5–7^{mm} long: corolla white, its tube as long as the calyx: nutlets narrowly ovate, angled at the sides, densely muriculate on the back and sides, ridged on the back by a double row of minute tubercles, scar open lanceolate, about 3^{mm} long, rarely all maturing.

This plant was first collected in 1894, and now again from near the same locality in excellent flower and fruit. In habit it is intermediate between *O. suffruticosa* Greene and *O. caespitosa* Aven Nelson, but perhaps more nearly allied to the latter, from which it is at once separated by its silvery white foliage, its larger size, and muricate nutlets. No. 8309, collected on gravelly, open hilltops, Fort Laramie, Wyoming, is the type.

Mimulus membranaceus, n. sp.—A weak diffusely spreading annual, nearly glabrous throughout, but slightly clammy in the fresh state: stems slender, nearly prostrate, geniculate at the nodes, from a few centimeters to 1 or 2^{dm} long: leaves very thin, elliptic to broadly ovate, entire or crenate-dentate, on pedicels about equaling the blade: flowers in the axils, on filiform pedicels which are several times longer than the calyx: calyx tubular, obscurely glandular-pubescent, 2–3^{mm} long, the teeth small, much elongated, somewhat inflated and distinctly angled

in fruit: corolla yellow, very moderately bilabiate, nearly tubular, 5–8^{mm} long: capsule not stipitate, elliptic, obtuse, nearly equaling the slender style which barely protrudes from the mature calyx: seeds nearly oval, very small.

This is the counterpart in this range of *M. alsinoides* Benth. of the Washington-Oregon flora. From that species *M. membranaceus* differs principally in the enlarged and angled calyx, the scarcely bilabiate corolla (without the purple spot on the lip), and in the obtuse capsule and orbicular seeds.

Of the three collections of this all were secured in the Medicine bow mountains, always growing more or less in the shade of wet rock ledges and cliffs; nos. 1515 (1895); 1683 (1895), type; and 7729 (1900).

MIMULUS LEWISII **tetonensis**, n. var.—Smaller than the species in every way, more granular-glandular: calyx lobes shorter, narrowly linear-acuminate: corolla shorter, white or tinged with yellow.

Collected by Elmer D. Merrill and E. N. Wilcox in the Tetons, Wyoming, at 11,000 ft., near Lee's lake, July 26, 1901; no. 1072.

PENTSTEMON COMARRHENUS Gray —I wish to call attention to the distinctness of *P. comarrhenus* Gray (Proc. Am. Acad. **12**: 81) and *P. strictus* Benth. (DC. Prod. **10**: 324). *P. strictus* in Gray *Syn. Fl.* **2**: 262 seems to include both, though probably referring mainly to the plant of Utah and western Colorado. *P. strictus* was founded upon immature specimens collected by Fremont on the Platte river in Wyoming, where it is abundant, though apparently not again collected until within the last few years, hence the confusion. Good specimens of the two species when compared leave no doubt as to the validity of both. Typical specimens of *P. strictus* are my nos. 1472, 1579, 3079, and others from Wyoming and adjacent Colorado. Of the other species Mr. M. E. Jones's no. 5484, Castle gate, Utah, seems to me to be typical. Mr. Baker's no. 604, Piedra, Colo., will also probably go here.

Pentstemon xylus,[1] n. n.—*P. caespitosus suffruticosus* Gray, Syn.

[1] This description and the notes upon it were written before I discovered Dr. Rydberg's *Pentstemon suffrutescens*, Bull. Torr. Bot. Club **29**: 503. From the very limited notes there given I judge that he and I are considering totally different plants. As I feel quite certain that I have the true *P. caespitosus suffruticosus* Gray, I still present this description. If I be right, Dr. Rydberg's *P. suffrutescens* is practically a *nomen nudum* until he presents a description of it.

Fl. **10**: 270; not *P. suffruticosus* Dougl., Benth. in DC. **10**: 330.—Caudex woody, its branches prostrate spreading: the annual herbaceous stems slender, erect, not crowded, sparsely leafy, finely puberulent, 1–2^{dm} high: leaves linear-oblanceolate to spatulate, acute or obtuse at apex, tapering very gradually to the slender base, 1–2^{cm} long, shorter than the internodes, nearly or quite glabrous: inflorescence open; the short peduncles at right angles to the stem, with about three short-pediceled, nearly erect flowers: sepals nearly linear, sparsely glandular-pubescent, about 4^{mm} long: corolla moderately ventricose, with sub-equal lips, obscurely and sparsely glandular pubescent, a few long hairs in the throat: the sterile filament moderately bearded to its base.

The specimens before me were collected by Mr. H. N. Wheeler at Sapinero, Colo., 1898, no. 446, and in my judgment are referable to *P. caespitosus suffruticosus* Gray. As suggested by Dr. Gray, this seems to be a distinct species, though clearly related to *P. caespitosus*.

Pentstemon Owenii, n. sp.—Perennial from a much branched, cespitose, woody caudex, 1–2^{dm} high: stems numerous, erect from a more or less decumbent base, rather slender, glabrous, or with an obscure puberulence, most of them tinged with purple, some of them deeply so: leaves glabrous, numerous on the crowns of the caudex (many of the branches of the caudex terminating in short, slender, sterile, leafy shoots), narrowly elliptic (some of the earlier ones from obovate to spatulate), mostly acute at apex, 2–4^{cm} long, tapering cuneately at base into a petiole which is usually much shorter than the blade (rarely nearly equaling it); the stem-leaves several, the lower much like those of the crowns, becoming narrower and lanceolate upward, passing into the bracts of the inflorescence: thyrsus crowded, from capituliform to short spicate and somewhat interrupted-verticillate, minutely glandular-pubescent especially on calyx and pedicels: sepals lanceolate, one-third as long as the corolla, the broadish base scarious margined, the green central portion continued into the acuminate tip: corolla violet-blue (or sometimes purplish?), tubular, but slightly dilated upward, 12–15^{mm} long. only

moderately bilabiate; the lobes entire, rounded, sparsely bearded on the lower lip: sterile filament but slightly enlarged upward, rather stiffly bearded at tip; anthers dehiscent through the junction of the cells, but not explanate.

That the large number of forms that have figured as *P. confertus* Dougl. and varieties of it have given rise to no little trouble is admitted by all. An aggregate is always confusing. As tending toward a simplification, it seemed to every one proper to restore to specific rank *P. procerus* Dougl., published by Graham in Edinb. Phil. Journ., 1829. This, so long known as *P. confertus caeruleo-purpureus*, is so evidently distinct that no one ever thinks of mistaking it for the species to which it has been appended.

The species now proposed, while a member of this same group, is as distinct from *P. procerus* as the latter is from *P. confertus*. The habitat of the two is characteristic. *P. procerus* is found at middle elevations and up to the limit of trees, occurring on moist slopes and in the valleys. *P. Owenii* is strictly alpine and occurs in clumps among the rocks of the "slides." The former is glabrous, the latter puberulent on the stems and glandular-pubescent on the inflorescence. The inflorescence of the former is nominally verticillastriform, of two to five rather remote verticils; the latter is spicate-capitellate with at most one proximate verticil, and the corollas of the latter are much larger than in the normal form of the other, less strongly bilabiate, and relatively longer when compared with the calyx.

This species is dedicated to that intrepid mountaineer, Hon. W. O. Owen, who in September 1898, with a small party, successfully scaled the Grand Teton and left upon its summit permanent record of the achievement. Mr. Owen brought back from this memorable trip several specimens of alpine plants, among which was a specimen of this species. It has been collected again in 1899, August 16, by the writer, this time also on the Tetons at an alpine station, no. 6515 being the type. More recently collected by Messrs. Merrill and Wilcox, 1901, and again on the Tetons.

Synthyris flavescens, n. sp.—Nearly glabrous throughout from the first, green even to the floral bracts: rhizome thick, short, horizontal, with numerous thick, fibrous roots: stems few to several, strict, leafy-bracteate, 3–5^{dm} high: leaves few, radical, ovate-lanceolate, sub-acute, finely serrate-crenate, 6–10^{cm} long, mostly exceeding the comparatively slender petioles; the foliar bracts of the stem broadly ovate, acute, serrations similar to those of the leaves, 1–2^{cm} long; floral bracts ovate-rhomboid to lanceolate, acute, entire or very unequally two-lobed, sessile

by a narrowed base, sparingly ciliate-margined as are also the sepals: spike dense, 5–10^{cm} long; the flowers short-pediceled: calyx unequally 4-cleft, the lobes elliptic, toothed at apex: corolla yellow or greenish-yellow, cleft at either side nearly to the base; the upper lip broadly obovate, with cuneate base and entire or toothed summit, exceeding the calyx and the 2–3-cleft lower lip by about half: stamens exserted, with purplish filaments and yellow anthers: mature fruits not at hand.

This species was collected and distributed by Professor C. S. Crandall as *S. plantaginea* Benth. To this it is allied, but more closely to *S. Ritteriana* Eastwood, though even from this it differs in many essential respects. Collected at Cimarron, Montrose co., Colo., May 18, 1898.

SYNTHYRIS RITTERIANA **obtusa,** n. var.—Leaves very obtuse, exceeding the scarcely margined petiole; foliar bracts suborbicular, usually cuspidate; floral bracts merely acute, distinctly purple-veined on the inside, with a narrowed base but not petioled: calyx parted to the base at the sides, the two lobes similar, orbicular or reniform, sometimes one or both from slightly to deeply cleft near one side, thus giving a 3 or 4-cleft calyx of unequal lobes: corollas yellowish-white, slightly exceeding the calyx, the two lips parted to the base; the upper lip rounded or truncate; the lower nearly similar or laciniately toothed or lobed.

If the above characters, which are mainly points of distinction between this plant and *S. Ritteriana*, are not specific, they at least call attention to a good variety. The specimens are those distributed by Messrs. Baker, Earle, and Tracy, no. 225, as *S. Ritteriana*, and bearing the note "this but a short distance from the type locality where it was also observed." In spite of the locality, the plant fails to measure up to the characters, and must be at least varietally distinct. In case the now proposed variety must later be included into the species, the description of the latter will have to be materially modified; but in the absence of the type specimen I leave it as a variety.

Gaertneria tomentosa (Nutt.), n. comb.—*Ambrosia tomentosa* Nutt. Gen. **2**: 186. 1818; *Franseria discolor* Nutt., Trans. Am. Phil. Soc. n. ser. **7**: 345. 1841; *Xanthidium discolor* Delpino, Studi sopra Artemis 62. 1871.—That Nuttall's *Franseria discolor* is simply his *Ambrosia tomentosa* seems more than probable. As

Dr. Gray states in the *Syn. Fl.*, "station and characters" indicate this. In the *Kew Index* this synonomy is accepted without question. Then, too, Nuttall's characterization, "leaves tomentose on the lower surface," would imply that the upper surface was not tomentose. It is true also that while Dr. Gray in *Pl. Fendl.* thought his *Franseria tomentosa* was Nuttall's *Ambrosia tomentosa*, he changed his mind about the matter in a later publication (*Syn. Fl.* 251).

Gaertneria Grayi, n. nom.—*Franseria tomentosa* Gray, Pl. Fendl. 80.—Since the preceding change necessitates another, this species may appropriately be dedicated to the original describer.

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THREE NEW GENERA OF THE HIGHER FUNGI.

GEO. F. ATKINSON.

(WITH THREE FIGURES)

I. EOMYCENELLA, A NEW GENUS OF HYMENOMYCETES.

THIS interesting plant was found during September 1899, on fallen leaves of *Rhododendron maximum* at Blowing rock, N. C. The plant is very minute, entirely white, possesses a delicate pileus which is broadly campanulate or depressed in age, and a very slender, fleshy stem. An examination with the hand lens showed that there were no lamellae, the underside of the pileus being plane. The Rhododendron leaves, partly dry, rolled in such a way as to protect the fungus, and in this condition it was shipped to Ithaca. On examination with a higher power microscope, it was found that the hymenium had dissolved so that the spores lay against the underside of the framework of the pileus in the amorphous layer of dissolved tissue. From this material it was clearly impossible to determine the structure of the fungus. The leaves were then placed in a moist chamber, and in the course of a few days a new plant appeared, and for some time successive ones grew and I was enabled to study the structure.

For some time none of the plants showed any trace of lamellae, and it appeared that the fungus belonged to the Thelephoraceae. but later one plant was grown somewhat larger than the others, which had rudimentary lamellae, eight of a larger size and four very small. This at once opens the question as to whether the plant belongs to the Thelephoraceae or to the Agaricaceae and whether originally the hymenial surface was plane, and the form with lamellae represents a later stage in the evolution of the plant; or whether the gill form represents the original character of the species, which by reduction loses its lamellae. The latter condition is seen sometimes in *Marasmius epiphyllus* Fr.,[1] and I have

[1] PERSOON, Icones *pl. 9. fig. 7.*; STEVENSON, Brit. Fung., Hymen. **2**: 152.

seen specimens of *Lepiota procera* in which large areas on the under side of the pileus were destitute of lamellae. The additional characters of the fungus are to be found in the following description:

EOMYCENELLA Atkinson, n. gen.—Plants stipitate. Pileus campanulate to expanded, consisting of a layer of radiating branched threads forming a more or less lattice-like or trabecular, expanded, thin structure; trama wanting or very rudimentary the subhymenium arising directly from the trabeculae of the pileus. Hymenium plane, or in larger forms with a few short, narrow, distant lamellae not reaching the stipe; lamellae with rudimentary trama. Basidia clavate, 4-spored. Spores smooth, 1-celled, hyaline. Stipe fleshy, delicate. At maturity hymenium dissolving, leaving many of the spores lying on an amorphous layer against the trabeculae.—One species, on decaying leaves of *Rhododendron maximum*, Blowing rock, N. C.

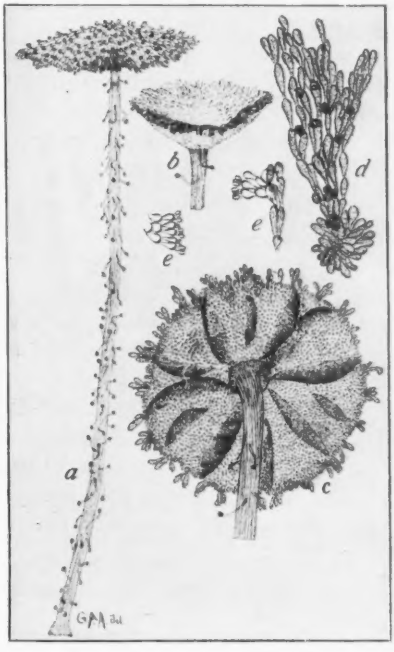

FIG. 1.—*Eomycenella echinocephala*: *a*, entire plant; *b*, pileus in older stage; *c*, under side of pileus, showing rudimentary gills in larger plant; *d*, detail of trabeculæ of pileus; *e*, detail of basidia and spores.

Eomycenella echinocephala Atkinson, n. sp. (*fig. 1*).—Plants white, 3–8 mm high. Pileus 0.5–0.75 mm broad. Stipe 60–80 μ in diameter. Plants campanulate to expanded and upturned in age, trabeculae of upper surface echinulate, bearing here and there

globose free branches, 10–15 μ in diameter and also echinulate, margin of pileus with free clavate branches in the form of a fringe. Cells of the trabeculae 25–30 × 6–10 μ. Hymenium plane or with few short, narrow gills. Gills when present narrowed at each end, not reaching the stipe. In the plant observed 8–10 long lamellae, 4–6 intermediate ones much shorter. Subhymenium loosely branched, obovate cells arising from the trabeculae and terminating in the basidia, or in the forms with lamellae arising from a rudimentary trama in the lamella. Basidia short clavate, abruptly narrowed into a pedicel, 9–12 × 6–9 μ, 4-spored. Spores obovate-oblong, elliptical, proximal end pointed, 6–8 × 3–4 μ, hyaline, smooth, granular. Stipe thread-like, with scattered hairs bearing a short echinulate cell on the end. Base of stipe only slightly broadened.

Eomycenella is related to *Discocyphella*[2] P. Hennings, but differs in the dissolving hymenium and the fact that the pileus is not gelatinous nor the stem horny. From *Cymatella*[3] Patouillard (placed with Agaricaceae) it differs in the trabecular pileus and the dissolving hymenium; and from *Gloeocephala*[4] (Clavariaceae) Massee, which has one-spored basidia. The latter should be placed in the Thelephoraceae.

II. EOTERFEZIA, THE TYPE OF A NEW GENUS AND FAMILY OF ELAPHOMYCETES.

This fungus appeared as a parasite on Sordaria grown in the laboratory in the spring of 1897. Cow dung which had been lying on the ground all winter was collected early in the spring of 1897 in a pasture field just beyond Buttermilk creek, near Ithaca, N. Y. This was placed in a moist chamber and in the course of a few weeks the Sordaria made its appearance. The species of Sordaria was not determined. After the cultures had been kept a week or so longer, there appeared on the perithecia of Sordaria minute white, knot-like protuberances which were smaller than the perithecia and stood out in strong contrast to the dark brown wall of the host. These minute bodies, subglobose or kidney shaped, were nearly smooth, possessing a few scattering free threads arising from the surface, and their texture was soft and fleshy.

[2] ENGLER and PRANTL, Pflanzenfamilien 1[1]: 554. [3] *Ibid.* p. 555. [4] *Ibid.* p. 131.

On examination of the structure it was at once clear that the fungus was a very interesting one. Nearly the entire interior of the fruit body is occupied by minute asci, not collected into a single tuft as in the pyrenomycetes, but scattered and intermingled with the mycelium. The asci are separated into small fields by radiating strands or thin plates of mycelium, forming sterile avenues from which the branches arise that ultimately bear the asci and are intermingled with them. Since the fields of asci are more or less elongate and thin, they too, have a more or less radial direction from the point where the fruit body is in contact with the host. The surface of the fruit body is a thin and delicate wall formed by the coalescence of hyphae into a membranous envelop which is joined by the terminations of the radiating sterile avenues.

The arrangement of the asci in fields separated by sterile avenues of mycelium suggested that the fungus was related to the Tuberineae. However, the asci do not form a hymenium lining the walls of chambers in the interior, but they are irregularly intermingled in the fields which they occupy. This places the fungus definitely in the order Plectascineae.[5] In Fischer's arrangement of this order there are six families. In the first three families, Gymnoascaceae, Aspergillaceae, and Onygenaceae, the asci are irregularly distributed throughout the interior of the fruit body, while in the Elaphomycetaceae and Terfeziaceae[6] there are sterile avenues separating the fertile fields into groups. It is evident that our plant possesses certain points of close agreement with these two families, but the internal structure is much more simple, and the asci and spores are not so highly specialized, while the thin membranous, rudimentary envelop is very unlike the thick and differentiated wall of the members of these two families.

It is evidently a plant of very simple structure. It shows some points of resemblance in this respect with the Gymnoasca-

[5] ENGLER and PRANTL, Pflanzenfamilien 1^1: 290.

[6] The Trichocomaceae have a highly specialized and peculiar capillitium, too remote from our plant for comparison.

ceae; but, as stated above, the differentiation of the interior into sterile avenues and fertile fields does not admit of its location in that family. Furthermore, the envelop of the fruit body in the Gymnoascaceae is arachnoid, while the envelop of our plant, though simple and very thin, is membranaceous. It represents

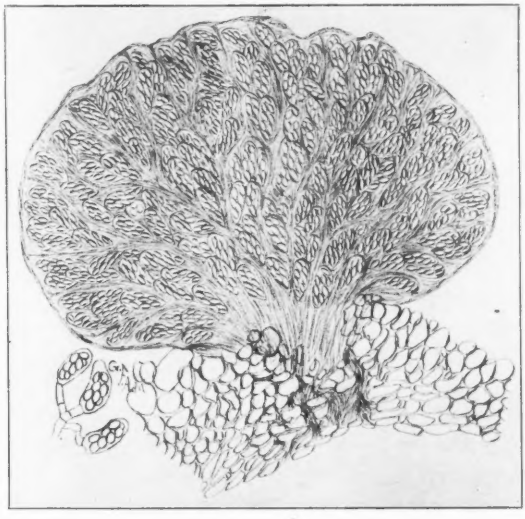

FIG. 2. *Eoterfezia parasitica*, showing section of fruit body and portion of perithecial wall of Sordaria.

not only a new generic type, but also the type of a new family. These may be characterized as follows:

EOTERFEZIACEAE Atkinson, n. fam.—Fruit bodies with a thin but distinct wall of closely interlaced hyphae. Interior with sterile avenues connected with the wall and separating the fertile areas where the asci are irregularly arranged.

EOTERFEZIA Atkinson, n. gen.—Fruit bodies subglobose, minute, fleshy, with a distinct but very thin, undifferentiated wall, smooth or slightly hairy. Interior of fruit body with sterile avenues radiating from the base and branching until they unite with the wall. Fertile areas lying between containing the asci

intermingled with the supporting hyphae. Spores smooth, hyaline, one-celled. Interior not disintegrating into a powdery mass at maturity. At present one species as follows:

Eoterfezia parasitica Atkinson, n. sp.—Fruit bodies subglobose to kidney shaped, white, fleshy, 100–300 × 100–200 μ, sessile, closely attached to the perithecia of the host, the mycelium issuing from the inside of the perithecium in a broad, stout strand, and then radiating. Wall of the fruit body distinct and well differentiated, but very thin (3–5 μ), membranaceous, and undifferentiated, with here and there rather long free branches of mycelium, but not distinctly hairy. Sterile avenues radiating from the point of attachment with the host, and branching as they approach the periphery, thin, but distinct, and separating the fertile areas into thin plates in which the asci are intermingled with the hyphae. Asci elliptical-oblong, 15–20 × 8–10 μ. Spores elliptical-oblong, smooth, 3–3.5 × 1.5–2 μ, biseriate.—Parasitic on perithecia of a Sordaria, Ithaca, N. Y.

It might be as well to consider the position which the Eoterfeziaceae occupy in relation to the other families of the Plectascineae. When I first discovered the plant, I was impressed with the resemblance of the asci and spores to those of Ascocorticium of the Protodiscineae, and those of some species of Endomyces of the Protoascineae. It is probably more nearly related to the latter. But the Gymnoascaceae, especially the genus Arachniotus, show very close relationship to Endomyces, both in the arachnoid envelop and in the undifferentiated condition of the fertile portion. Eoterfezia is perhaps an offshoot from such a plant as Arachniotus. The relationship of the families might be suggested by the following scheme:

Gymnoascaceae
- Aspergillaceae (? Erysiphaceae).
- ? Onygenaceae.
- ? Trichocomaceae.
- Eoterfeziaceae
  - Elaphomycetaceae.
  - Terfeziaceae.

KEY TO THE GENERA OF PLECTASCINEAE.

Interior of fruit body undifferentiated,
- Wall of fruit body arachnoid, simple — *Gymnoascaceae*
- Wall of the fruit body firm, thick,
  - Fruit bodies not stalked — *Aspergillaceae*
  - Fruit bodies stalked — *Onygenaceae*

Interior of fruit body differentiated,
Wall of fruit body very thin, membranaceous - - *Eoterfeziaceae*
Wall of fruit body stout,
Spore mass powdery - - - - - - *Elaphomycetaceae*
Spore mass not powdery - - - - - *Terfeziaceae*
Interior of fruit body with a highly specialized capillitium *Trichocomaceae*

III. DICTYBOLE, A NEW GENUS OF PHALLOIDS.

This plant was collected by W. H. Long, Jr., at Denton, Texas, Oct. 15, 1901. It is peculiar and striking in that it possesses a dimorphic gleba, the upper part of which is traversed by sterile, radiating, imbricate plates suggesting the gleba of Itajahya, while the lower part of the gleba is latticed something after the fashion of Simblum. From the gross characters of the gleba it would seem to occupy an intermediate position between the two genera, the former being placed by Fischer in the Phallaceae, while the latter is a member of the Clathraceae. However, in Itajahya the sterile plates are pseudoparenchymatous, while in Dictybole they are floccose, and Dictybole therefore belongs in the Clathraceae.

The upper part of the volva in the specimens seen remains adherent to the pileus, so that in the elongation of the receptacle the volva ruptures in a circumscissle manner, leaving the edge of the pileus more or less irregularly lobed and pendent around the upper part of the receptacle, though sometimes the volva ruptures so high up that there is no free portion projecting. As the plant ages, the latticed portion of the gleba loosens from the stipe, except at the junction with the upper part of the pileus, and expands in such a manner as to form a pendent, loose, open, large meshed irregular network, which becomes easily torn asunder in several places. The plant when fresh has a peculiar, but pleasant and strong "amyl-acetate" odor. It represents the type of a new genus[7], which may be characterized as follows:

DICTYBOLE Atkinson, n. gen.—Receptacle a hollow stalk with a chambered wall bearing at the apex a weakly devel-

[7] Dr. Ed. Fischer, to whom the plant was submitted, confirms my opinion that it represents a new genus.

oped pileus covered by the gleba. Gleba dimorphic, the apical portion traversed by numerous sterile, short, radiating plates; the lower portion with convoluted folds in the form of irregular rings giving a latticed appearance to this portion of the gleba. At maturity the folds of the latticed portion of the gleba uncoil more or less and form long, irregular, loose, netlike folds. Spores single celled, smooth.—One species, Denton, Texas.

FIG. 3.—*Dictybole texensis.*

Dictybole texensis Atkinson & Long, n. sp.—Plants subterranean, emerging by the elongation of the receptacle, 7–10^{cm} high. Receptacle nearly cylindrical, slightly tapering downward, cream white, firm; pileus not perforated at the apex, usually pendent from apex of receptacle, and upper part of volva often in contact. Gleba at first drab, then black; sterile plates in upper part of gleba numerous, short, and narrow, arranged in a more or less radiating and imbricated manner; latticed portion with large oblong rings (8–16?), the surface rugose, and in age loosening out into a large open, irregular mesh. Spore bearing tissue between the sterile plates and lying between and over the lattice work. Spores pale olive brown, irregularly oval, 3–4 × 2–3 μ, smooth. Volva large, white, circumscissle, rooting at the base. The plant when fresh has a pleasant but strong "amyl-acetate" odor.—In sandy soil. Denton, Texas.

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NOTES ON THE PHYLOGENY OF LIRIODENDRON

EDWARD W. BERRY.

(WITH ONE FIGURE)

THERE are many reasons why the tulip tree is an object of unusual interest, but its scientific interest chiefly arises from the facts that, like the Sequoia, Sassafras, Platanus, Ginkgo, etc., it is the lone survivor of an ancient race extending back into the Cretaceous period, that most of the race history can be traced, and that we find this history epitomized in the existing species.

Liriodendron Tulipifera is confined to the eastern portions of North America and Asia, although it or its probably identical representatives were common in Europe during the Tertiary period. Like other trees peculiar to North America at the present time, such as Magnolia, Liquidambar, Sassafras, etc., and which inhabited Europe during the Tertiary, it was forced to the Mediterranean by the glaciers and exterminated. The existing Asiatic form has been described as a variety (*chinensis*[1]), but it is very doubtful whether it is distinct. In North America the tulip tree is found from Vermont to Florida and westward to Michigan and Arkansas, and appears to be confined to the humid temperate realm, requiring a rich soil for its full development.

The great variability among the leaves of the tulip tree, as well as the resemblance of some of them to fossil species, has attracted very little attention, possibly, as Holm suggests,[2] because this variability is so well known as not to merit discussion. The belief that this is not the case has led to the following notes, extending over a number of years, and based upon innumerable specimens. While these notes are incomplete and

[1] Descriptions of some new phanerogams collected by Dr. Shearer in China, etc., Jour. Bot. **13**: 225. 1875.

Enumeration of all plants known from China, etc. F. B. Forbes and W. B. Hemsley. Jour. Linn. Soc. **23**: 25. 1886.

[2] Proc. U. S. Nat. Mus. **13**: 15–35. 1890; BOT. GAZ. **20**: 312. 1895.

disconnected in many ways, it has seemed best to arrange and present them.

A common error is the belief that a truncate or emarginate apex is a constant feature, induced, no doubt, by a consideration of the vernation, which would seem to preclude any other form of apex, and which has been the subject of papers by Lubbock[3] and others. Lesquereux[4] says "leaves always truncate or emarginate at the apex," and Newberry[5] makes the same statement. Holm,[6] in his paper on the leaves of Liriodendron, goes still further, and insists that the notched apex is the true test of the genus Liriodendron, and hence unnotched leaves or forms with the apex of the leaf missing cannot be identified with certainty; and Hollick[7] makes the statement that the apex is always cuneate or notched. Doubtless others have followed the lead of these authorities.

I have collected numerous leaves of *Liriodendron Tulipifera* with pointed tips, and I have also a number of similar specimens collected by Mrs. W. A. Kellerman, of Columbus, O., showing how fallacious the above cited criterion proves. Among my collections of these anomalous forms may be noted a simple obovate leaf closely resembling *Phyllites obcordatus* Heer; a trilobed form identical with *Liriodendron semialatum* Lesq. of the Dakota group; a small leaf unlike anything before known in this genus and almost exactly corresponding with *Cissites acuminatus* Lesq., *pl. 5, fig. 3*, of his *Cretaceous and Tertiary Floras;* a large trilobed leaf which is also a new form in the genus and recalls Heer's *Aralia groenlandica;* also numerous ovate-lanceolate leaf blades on leaf bearing flower buds (see *fig. 3*). The foregoing examples are sufficient to refute the claim that the notched apex is an essential character, and we should expect to find just such leaf forms if we accept the origin of Liriodendron from forms with simple, magnolia-like leaves. Fossil species based on leaf forms

[3] Phytobiological observations. Jour Linn. Soc. **22**: 24. 1887; and GODRON, A., Obs. sur les bourgeons et sur les feuilles des *Liriodendron Tulipifera*. Bull. Soc. Bot. France **8**: 1861.

[4] Flora of Dakota group, p. 229.

[5] Flora of the Amboy clays.

[6] Proc. U. S. Nat. Mus. **13**: 1890.

[7] Proc. Nat. Sci. Ass. Staten Is. **5**: no. 7. 1896.

alone are always more or less problematical, and yet in many cases form alone has served for specific distinction.

Venation also is much depended upon in defining species, although both venation and leaf form are characters which vary in a marked degree in the modern tree, even on the same individual. Leaving out the anomalous forms from shoots, forced buds, saplings, etc., almost any sassafras or tulip tree will show a more or less wide variation among mature leaves on branches which theoretically (*i. e.*, fruiting branches) should bear typical leaves; and when we compare a series from different trees or of different ages the variation in shape and minor characters of venation is almost endless. Perhaps no style of venation is more characteristic generically than the peculiar form that obtains in Liriodendron. That it cannot be relied upon for specific distinctions we know from its wide variation on the living tree, as well as among the fossil species referred to this genus. In some specimens the secondaries are opposite instead of irregularly alternate; in some they are parallel almost to the margin and ascending; while in others they soon divide. The angles of divergence of the secondaries show every degree of divergence, acute angles, right angles, or obtuse angles. All that should be claimed for venation characters, generally speaking, is usefulness in generic distinction or as supplementary evidence in connection with species.

Holm considers nearly all of the described forms of Liriodendron invalid, while most authorities consider nearly all of them perfectly good species. Professor Ward's dictum, that for geological purposes it is not so much a question of correct botanical determination as the correct recognition of a plant once named and associated with a given deposit, is quite true; but it loses its force when we are considering forms with variable leaves, unless each variety is constant and peculiar to a given formation, which is obviously not the case. In pursuing the comparison through the intermediate forms of ancient Liriodendrons, who can say where to break the chain of gradations for the boundary of separate species; among the gradual modifications of form, strikingly similar to

a series of leaves of *Liriodendron Tulipifera*, who can say where *L. simplex* ends and *L. primaevum* or *L. Meekii* begins, or where *L. primaevum* ends and *L. semialatum* begins? The same variability and interrelation is shown among the leaves variously referred to Aralia, Sterculia, Cissites, Menispermites, Protophyllum, Platanus, Sassafras, etc.; and, while it may be argued that we should expect just such variable and intermediate leaves at a time when the flora of the globe was becoming rapidly differentiated, the argument loses force when we turn to a similar variability and interrelation of the modern forms of the same genera, when their leaves alone are considered.

In considering the thirty or more species and varieties of fossil forms ascribed to Liriodendron and its allies Liriodendropsis and Liriophyllum, we may distinguish them as all good species, or as three or four, or we may identify most of them with the modern form, dependent upon our conception of the term species. If the Cretaceous period, at the time the Dakota strata were being laid down, was the time of maximum development and diversification of the dicotyledons, it is difficult to understand how so many of the types are still persistent with all their essential characters unchanged (Myrica, Betula, Quercus, Populus, Viburnum, Salix, etc., and representatives of nearly all of the natural orders), even in some cases to specifically similar forms (as *Magnolia acuminata* and *M. tripetala*). If there was such a diversification of species at that time as we are led to believe, it is strange that most of the types persist comparatively unaltered through the later formations to the present time, instead of losing their character in further continued variation.

We have listed as follows a few of the reasons for considering some or all of the described species of Liriodendron invalid:

1. Their remains are more or less fragmentary, and therefore not determinable with certainty.

2. The shape and venation of leaves are poor specific characters at best.

3. A series of leaves of *Liriodendron Tulipifera* can be found which parallels the fossil species in both shape and size.

4. There is a close intergradation among the various fossil forms.

5. The more unusual fossil forms are mostly small leaves, and it is among the smaller leaves on shoots and saplings of *Liriodendron Tulipifera* that we find the most diverse shapes, and those forms which most resemble the diverse fossil forms.

6. The remains of different fossil species would be unlikely to occur associated with each other.

7. Liriodendron is a monotypic genus at the present time.

8. The existing tulip tree very probably extends back into the Tertiary period, there being no great climatic change except during the Glacial period, which was survived by all of our existing arboreal vegetation. It is not stretching a point, therefore, to assume that our existing species of Liriodendron might extend still farther back into the Cretaceous; other plants do (Magnolia), and paleontology affords many examples of such persistent animal types.

9. Nearly all of the fossil forms of Liriodendron, if found at the present time, would be unhesitatingly referred to *L. Tulipifera* from a consideration of their leaf form alone; and practically all of the abnormal leaf forms of *L. Tulipifera*, if found as fossils, would be considered distinct species.

10. If we assume that in the ancient forms of Liriodendron the largest and best developed trees were on hillsides, as is the case in the modern tree, then the smaller, more aberrant forms, which occur on vigorous saplings and shoots, inhabiting the more marshy situations, would be the forms mostly likely to become fossil.

11. A warm, humid climate during the Cretaceous might account for the variety in shape and size of the leaves, just as in *L. Tulipifera* the best nourished individuals are the most variable.

12. The fact that so many of the fossil forms were contemporaneous militates against considering them as different stages in the development of the genus. We might with equal propriety consider the existing varieties as actual stages.

13. The barren record of the Tertiary period would seem to

imply that the diverse forms are found in the Cretaceous simply because the conditions were favorable for the fossilization of the abnormal forms.

In opposition to the foregoing, our reasons for considering the various described species valid are:

1. The majority of abnormal leaf forms in the living *L. Tulipifera* are young leaves, and they would not be likely to become detached and preserved as fossils.

2. We have every reason to expect numerous species in a tree ranging over so many lands (Europe, Asia, America), and throughout such a long period of time (Lower Cretaceous to the present).

3. The Cretaceous was a period of development and variation in the dicotyledons.

4. Ontogeny, or the individual development of modern types, more or less parallels their phylogeny, or actual ancestry. Generally speaking, this applies to all animals and plants.

5. The weight of authority is all on the side of many species, Lesquereux[8] going so far as to say "from the remarkable diversity of characters seen in the leaves of Liriodendron described in this volume, I believe that no botanist would be disposed to consider them as mere varieties of the original obovate simple leaves." In criticising Holm's paper on Liriodendron, Professor Lester F. Ward[9] says "modern forms more likely represent the phylogenetic stages through which the present living species has passed." This is the view held by all, so far as I know, of the various authors who have written of this group, as Newberry, Lesquereux, Hollick, etc., in this country, and Heer, Ettingshausen, Unger, Saporta, Velenovsky, Massalongo, etc., abroad.

6. If stipules were present—and they must have been, since *Liriophyllum populoides* of the Dakota and *Liriodendron alatum* of the Laramie show their incipient stages—they should occur as fossils, either separately, if we assume them to have been fugacious, as they are at the present time, or attached to the petioles of the fossil leaves, if they were persistent.

[8] Flora of Dakota group, pp. 205, 206. [9] Am. Jour. Sci. III. 40: 422. 1890.

In reply to the question whether each one of the described species of Liriodendron represents a definite species established in nature, we are compelled to answer in the negative; for the evidence that the majority of these forms were distinct species, in any proper sense, is entirely insufficient. At the same time, we are led to believe, from a study of these fossil forms in conjunction with the modern form and its varieties, that Liriodendron in the course of its evolution has passed through a series of parallel stages, as we will endeavor to show. It matters little whether we call these stages species or stages.

The purpose of Holm's[10] paper on Liriodendron is stated as follows: "The object of these notes . . . . is to prove that, as far as is known to the writer, there is not a greater difference in the foliage between many of the extinct species of Liriodendron than between a series of leaves from a very young tree or from a branch of an older one of our living *L. Tulipifera*;" and he then proceeds to attack the validity of the various species. Since 1890 a host of specimens, including many interesting forms,[11] have come to light, and much new material has been published. Two works in particular may be mentioned, the last labors of the pioneers Lesquereux[12] and Newberry[13] being issued posthumously, as well as various contributions from Hollick and others on the plant remains from Long and Staten islands and elsewhere. The time seems opportune for recording some additional notes, and correcting several current inaccuracies. It is far from the purpose to attempt to diminish or increase

[10] Proc. U. S. Nat. Mus. **13**: 16. 1890.

[11] The following new species: *Liriodendropsis angustifolia* Newb., *l. c.*, p. 84; *Liriodendron alatum* Newb., Hollick in Bull Torr. Bot. Club **21**: 467. 1894; *L. acuminatum bilobatum* Lesq., *l. c.*, p. 207; *L. Snowii* Lesq., *l. c.*, p. 209; *L. succedens* Dawson, Trans. Roy. Soc. Canada **11**: 62, *pl. 8. fig. 26.* 1893 (1894); *L. praetulipiferum* Dawson, *l. c. fig. 27;* and the winged petiole forms of *Liriophyllum populoides* Lesq., Hollick, *l. c.*

[12] Flora of Dakota group, edited by F. H. Knowlton. Monograph 17 U. S. Geol. Surv. 1891.

[13] Flora of the Amboy clays, edited by Arthur Hollick. Monograph 26 U. S. Geol. Surv. 1895.

the number of described forms of Liriodendron, and so needlessly encumber the synonymy.

In comparing the ancient types of Liriodendron with the modern varieties of *L. Tulipifera*, the purpose is to establish the fact that those ancient forms of leaves which were simple, or with unnotched apices, or with winged petioles, and which some authorities are inclined to exclude from Liriodendron, are undoubtedly correctly identified as primitive forms of that genus.

THE EVOLUTION OF LIRIODENDRON.

Following Holm, we would consider the primitive ancestral type of Liriodendron to have been a simple, Magnolia-like leaf; for not only do all the modern relatives of Liriodendron have such leaves (Magnolia, Anonaceae, etc.), but there is a progressive simplification and reduction in lobation as we proceed back in time, the most primitive known forms having ovate or oblong simple leaves (*fig. 3*). We find in the growth of our modern *L. Tulipifera* a parallel development, from the youngest entire or merely notched forms to those of the mature, typically lobed leaves.

Generally speaking, no significance can be attached to the form of the cotyledons; but in this case they represent almost exactly the form we imagine to have been assumed by the primitive Liriodendron leaf, which grew in the early Cretaceous or Jura-Cretaceous. (See Torreya **2**: *pl. 1. figs. 6–8.* 1902.) We picture this ancestor as a tree with simple, ovate or lanceolate leaves, short petioled and without stipules or bud-scales. The vernation of the leaves was probably conduplicate, as in the existing Magnolia, it being obviously improbable for it to have been reflexed in the ancestor of short-petioled leaves such as those of *Liriodendron simplex* and *L. primaevum.* We consider that this entire, oblong form of leaf, tapering at both ends to a blunt point, was succeeded by a series of forms ranging from *Liriodendropsis angustifolia* Newb. at the one extreme, through *Liriodendron simplex* Newb., *L. primaevum*

Newb., and *L. Meekii* Heer, to *L. semialatum* Lesq. at the other.

This more or less closely related group includes four types of leaves. The first, a narrow elongated leaf, with an emarginate apex (*Liriodendropsis angustifolia*), occurs in such numbers in the Amboy clays and is so uniform in shape as to warrant its consideration as at least a permanent variety, which developed from the simple lanceolate ancestral form by a reduction of the apex until it became emarginate in the Lower Cretaceous. The second type includes certain leaves which have been referred to *L. simplex*, and which resemble the preceding in outline, but are somewhat broader. They would have been developed easily from *Liriodendropsis angustifolia* by a slight shortening and broadening of the blade of the latter; and like it, this form is found in the Amboy clays. If we compare some of the figures of *L. simplex* with Lesquereux's *Myrsine crassa*,[14] they seem to be identical.

The third type of leaf is connected with the preceding by insensible gradations from the elongated emarginate forms, showing a constantly increasing width of blade, together with a shortening of its length, the emarginate apex becoming less and less so, until it is simply retuse. If these leaves were somewhat shortened and broadened, they would be identical with the usual form of young leaves of *L. Tulipifera*. If *Phyllites orbicularis* Newb. (Flora Amboy clays, 136. *pl. 24. figs. 7, 8*) be compared with young leaves of *L. Tulipifera*, they seem very similar and possibly identical. The various fossil leaves referred to *Colutea primordialis* Heer are also of this type, and the same may be said of *Sapotacites retusus* Heer.[15] The resemblance of these ancient Liriodendron leaves to various leaflets of existing Leguminosae has also been noted by several authors. We have found many specimens of *L. Tulipifera* leaves that belong here, which shows conclusively that these ancient leaves are true Liriodendron leaves. This type is represented by various fossil

[14] Flora Dakota group, *pl. 52. figs. 2, 3.*

[15] See Flora of Amboy clays, *pl. 53. figs. 5, 6.*

forms referred to *L. simplex* and *L. primaevum* Newb., showing every gradation in form from the elongated notched leaves through the typical *L. simplex* to the broad forms of *L. primaevum*, which show a tendency to develop four lobes, a stage reached in *L. Meekii* Heer. The typical forms of *L. primaevum* are later in point of time than *L. simplex*, being found in the Dakota group, which forms the lowermost layers of the Upper Cretaceous; while *L. simplex* begins in the Amboy clays, long thought to be the same age as the Dakota, but now referred to some of the later Potomac series (Albirupean) of the Lower Cretaceous. However, many of the forms which have been referred to *L. simplex* are intermediate between it and *L. primaevum*, there being no very clear lines of demarkation among *Liriodendropsis angustifolia*, *Liriodendron simplex*, *L. primaevum*, and *L. Meekii;* each being a modification of the preceding through insensible gradations. It is but a step from some forms of *L. primaevum* to *L. Meekii*, and we have among our collections of *L. Tulipifera* many leaves that approximate those of *L. Meekii* in shape.

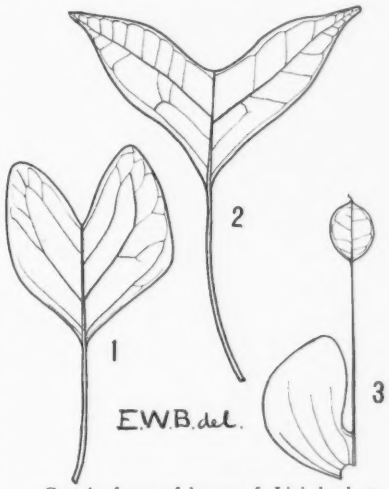
The fourth type of this group represents the other extreme of form, and is somewhat removed from the preceding three. It preserves the pointed apex of the original ancestor, which gradually broadened until it developed an obtuse basal lobe on each side. This form is represented among our known fossil forms by *Liriodendron semialatum* Lesq., and among leaves of *L. Tulipifera* by several specimens. *L. semialatum* is found in the Dakota group, and would have had ample time to develop into a broader leaf with basal lobes during the long period of the Lower Cretaceous when the Amboy clays were being deposited along our eastern coast. The small leaves from the Upper Cretaceous of Vancouver island, described by Dawson as *L. succedens*, if they belong to this genus would be the natural descendants of *L. semialatum*.

If we call the theoretical oblong-lanceolate form *stage 1*, the preceding five closely related leaf types fall naturally in a group which may be called *stage 2*.

Somewhat aside from the preceding are those forms included in Liriophyllum, a genus established by Lesquereux in 1876[16] to contain certain leaves from the Dakota formation evidently allied to Liriodendron. They are somewhat coriaceous in texture, with obscure venation, and differ widely in outline from any known forms of Liriodendron, being (except *L. obcordatum*, which is probably not a Liriophyllum at all) square or broadly rhomboidal in general outline, and split at the apex along the line of the midrib about half way to the base, the two lobes being sublobate or bilobate, and separated by an obtuse sinus. Just what is the relation between these leaves and Liriodendron is hard to say. We know of no forms of Liriodendron, either ancient or modern, that approach very closely the peculiar shapes of *Liriophyllum populoides*, and *L. Beckwithii*. *Fig. 1* shows the nearest form to Liriophyllum I have been able to find in some ten years collecting. In no case, however, is the resemblance very close, the nearest being those which would be identical with *Liriophyllum populoides* were the base somewhat wider. Bilobate leaves with a deep, wide sinus at the apex are common enough, the leaves tending to assume that form in the vicinity of flowers, or where the nourishment is defective; but none of them show any tendency to widen at the base, or contract the width of the sinus as in the leaves of Liriophyllum (*fig. 2*). There are two forms of Liriodendron leaves, either of which I conceive could have been ancestral to Liriophyllum. One is the common form of young leaves on modern shoots, and needs but to become parted farther down along the midrib, and to more largely develop the basal and apical lobes, to be a true Liriophyllum. The other is some form similar to *Liriodendropsis angustifolia*, which, by a shortening and widening of the blade, through some such form as *Liriodendron alatum*, might lead to Liriophyllum. Of the two, the latter seems to be the more tenable, for the orbicular notched leaves, first mentioned above, have never been found in the fossil state, unless *Phyllites orbicularis* may be so considered. It requires but a slight enlargement

[16] Hayden's U. S. Geol. and Geog. Survey, p. 482.

of *Liriodendropsis angustifolia* to secure a form similar to *Liriodendron alatum*, and by a slight shortening and broadening of the blade in the latter we obtain a form from which it is an easy transition to *Liriophyllum populoides*, through forms with slightly more ascending apical lobes, and with a greater development of the basal portion of the blade in a lateral direction. I would consider *Liriophyllum obcordatum* as co-laterally descended from some simple ovate form such as some of the forms referred to *Liriodendron primaevum*. In either case, a lengthening of the next to the last pair of primaries, and the resulting lobes, would give a form identical with *Liriophyllum obcordatum*. However, we do not consider this a true species of Liriophyllum; it is either a young and anomalous Liriodendron leaf, or a leaflet of some species of Leguminosae, preferably the former.



Certain forms of leaves of *Liriodendron Tulipifera*.

Liriophyllum populoides, the type of the genus, as the winged margins of the petiole show, had advanced several stages in the development of stipules. It is undoubtedly related to the ovate simple forms of the ancestral leaf through a form similar to *Liriodendron alatum*, as was just pointed out, possessing, as it does, the winged petioles of the latter. Lesquereux's two figures of *Liriophyllum populoides* have the petioles broken off, but both show the petiole widening as it descends. In the figure of a young leaf, the wings are in juxtaposition with the leaf blade, while in the older leaf there is an interval of petiole, apparently showing that the wings grew down the petiole as it lengthened. The immature leaf furnishes additional proof of its origin from

a form without the widely spreading base, showing ascending margins, and with but an indication of the spreading basilar extensions or lobes which characterize the mature leaves.

Liriophyllum Beckwithii is either an abnormal form of *L. populoides*, or a further extension and more pronounced development of its salient characters. Of rare occurrence and large size, it may simply represent a leaf of *L. populoides* of extraordinary size and more extensive lobation, induced by favorable conditions of growth, just as we find extraordinarily developed leaves of large size and extensive lobation on especially vigorous shoots from saplings of *L. Tulipifera*.

Sterile soil, lack of humidity, or some similar hard condition may account for the development of the Liriophyllum type of leaf. The following facts would seem to imply this: In *L. Tulipifera*, the leaves on the same twigs as the flowers tend to an abbreviated blade. Again, by cutting off the shoots of the year, and forcing next year's buds to take their places, we obtain leaves similar to the above. All of these forms approximate Liriophyllum, and hint at its probable mode of origin. That the peculiar ascending primaries offer no objection to this theory is well shown in several small specimens of *L. Tulipifera* leaves in my collection, with a cleft apex and opposite ascending veins. It would require only the slowly increasing development of an opposite-veined and cleft-tip form like this to become the opposite-veined, deeply cleft Liriophyllum.

As the Dakota time progressed, Liriodendron, fostered by the humid and warm Cretaceous climate, developed rapidly, the leaves increasing greatly in size, and with this went increased lobation, the tendency being for those portions of the leaf blade at the terminals of the secondary veins to increase at the expense of the rest of the blade. These lobes are obtuse where a full or an extra supply of nourishment is obtained, and acute where there is any diminution of the supply. That the congenial warmth, humidity, and rich soil of this period were the primary factors in the great variation and development of the Liriodendrons is undoubtedly the case; for in modern tulip trees those

growing in rich soil, or leaves on especially vigorous shoots from old stumps, saplings, etc., show the greatest tendency to variation and large size, and trees in poor soil have smaller acutely lobed leaves, and the leaves on large, mature trees are smaller than those on saplings, and have the lobation reduced almost to cuspidate points. Again, on individual shoots where the supply of nourishment is reduced artificially, or where it is diverted for the formation of flower and fruit, the leaves undergo great reduction in size and lobation, showing a tendency to assume a two-lobed, Liriophyllum-like form. There is nothing particularly new in this view, for we find in Lindley's *Introduction to Botany* (p. 136, 1839) the following: "Lobation [of leaves] is deepest and more pronounced in those individuals of the same species whose vegetation has been least favored by humidity, and the nature of the soil."

Large leaves, affording a larger assimilating area, are of course more advantageous in the performance of the functions of vegetation than smaller ones, and some of the additional advantages accruing when these large leaves are lobed instead of simple may be enumerated as follows: The simple leaves are more unwieldy and heavier, and therefore much more easily affected and broken by winds and rain. In the lobed forms the sunlight is more completely utilized; there is economy of circulation through more direct connection of parts; there are more leaves to a given amount of material, and therefore more active assimilating organs. The functional activity of two-lobed leaves, having an area equal to that of a single simple leaf, ought to be considerably greater.

The next stage in the genealogy of Liriodendron which has been preserved is *L. giganteum* Lesq., which is reached by a series of slight changes from the more primitive *L. Meekii* through constantly enlarging and more lobate forms induced by the environment indicated above. The petiole has become greatly lengthened, and stipules had probably been developed; for, although we have no trace of stipules except in the winged petioles of *Liriophyllum populoides* of the Dakota and *Liriodendron*

alatum of the Laramie, unless certain forms referred to Paliurus[17] are the remains of stipules, they must have been developed early in the history of the group, before the vernation became fixed and the petioles lengthened. *L. giganteum* had a very large leaf, 5 by 16.5 cm, with consequently large veins, oblique or rectangular, oblong, obtuse lobes, and deeply emarginate apex. We have a number of leaf forms of *L. Tulipifera* from particularly luxuriant saplings that greatly resemble *L. giganteum*. The venation is similar; the general contour is similar, the lobes in *L. Tulipifera* being a trifle less obtuse; and, like *L. giganteum*, these are very large leaves, in fact in all extra large leaves of *L. Tulipifera* the tendency is to assume a form that approximates *L. giganteum* in a general way, and we have a number of such forms in our collection. *L. giganteum cruciforme* Lesq. differs but slightly from *L. giganteum*, the lobes being more nearly at right angles and the intervening sinuses deeper and narrower; the lobes are also somewhat less obtuse and more like some of our specimens of *L. Tulipifera*. Dawson's *L. praetulipiferum* from the Upper Cretaceous is evidently related to *L. giganteum*. It also resembles some of the forms of *L. Meekii*, and is without doubt closely related to the then existing ancestor of our modern tulip tree.

The next species in the geological record is *L. oblongifolium* Newb. from the Amboy clays of New Jersey. Among the various published figures of this species all are fragmentary and of more or less uncertain affinity except one figure which shows a leaf surprisingly like the normal mature leaves of *L. Tulipifera*. In fact there can be but little doubt that *L. oblongifolium* is in the direct line of descent leading to *L. Tulipifera*, from which the latter has changed but slightly. *L. oblongifolium* is somewhat less lobate than the modern leaf, and has the lateral veins nearly straight, ascending, and approximately parallel. There is no doubt that *L. oblongifolium*, *L. praetulipiferum*, and *L. giganteum*

[17] See Flora of Amboy clays, *pl. 23, figs. 8, 9*; Flora of the Dakota group, *pl. 35, figs. 6, 7*; Bull. Torr. Bot. Club 21: *pl. 177, fig. 5*; Trans. N. Y. Acad. Sci. 12: *pl. 2, figs. 12, 18, 19*.

were very closely related, and probably had a common ancestor. Among the leaves of *L. Tulipifera* we can find a perfect series from *L. oblongifolium* to *L. giganteum* and *L. praetulipiferum* on the one hand, to *L. quercifolium* on the other. The latter was derived from *L. oblongifolium* through leaves with increased lobation.

The next fossil species is *L. pinnatifidum* Lesq., and we note that Lesquereux's two figures of this species differ considerably from each other in shape. Both are fragments, and their nervation is dissimilar and remote from that which obtains in all the other known forms of Liriodendron. While one may be a Liriodendron, we are forced to consider the other as an altogether different species, possibly allied to Quercus, at any rate not related to Liriodendron. We note in passing that Lesquereux's *Cissites obtusilobus*, also from the Dakota group (Fl. Dak. 161. *pl. 33. fig. 5*), somewhat resembles the species under discussion. Lesquereux[18] wrote later of Cissites as follows: "Velenovsky, in his Flora Bohm. Kreideformation, pt. 2, *pl. 6. fig. 2*, has a figure like this, and has named it *Liriodendron Celakovskii*. It essentially differs in the lateral primaries being basilar." We are inclined to think that this observation is a hint at the true affinity of the specimen, for it has the indefinable look of a Liriodendron leaf, and we have in our collection of *L. Tulipifera* leaves several that approximate *Cissites obtusilobus*. *Cissites alatus* Lesq. (Fl. Dak. group, 160. *pl. 23. fig. 6.* 1891) in all probability also belongs here. Lesquereux was inclined to refer it to Liriodendron, and afterward compared it with *L. Gardneri* Saporta, which it greatly resembles. We have also *L. Tulipifera* leaves that resemble it, but somewhat remotely.

The American Cretaceous species of Liriodendron at this time diverge somewhat widely from the line of descent leading to the modern form, and develop into some curious lobate forms that will be considered later.

We are obliged to go to Europe to find the stages subsequent to *L. oblongifolium* leading to *L. Tulipifera*. We find them nearly

[18] Flora Dakota group, p. 161, footnote.

complete in the forms variously referred to *L. Procaccinii* Unger, *L. Haueri* Ettings., *L. helveticum* Fish-Oester, *L. islandicum* Sap. & Marion, all from the European Tertiary[19] formations, the forms from the Pliocene being clearly identical with the existing species. Schmalhausen[20] refers a leaf from the Pliocene (?) of the Altai mountains to *L. Tulipifera*, and Saporta and Marion consider certain of the forms referred to *L. islandicum* as identical with the modern tree.

With the advent of the Glacial period the European Liriodendrons, along with Sassafras, Magnolia, Celastrus, etc., disappeared from that continent, the glacial conditions undoubtedly forcing them southward until further retreat was cut off by the Mediterranean.

Returning to the curious lobate forms from the American Cretaceous, we have four species and one variety that are unlike anything seen in the modern species, and evidently not forming a part of its ancestral line, but a collateral branch from it. The most lobate forms found on the modern tree are quite different from the long, narrow-lobed forms under consideration. The least divergent form is *L. intermedium* Lesq., and it is only known from fragments of the upper part of the leaf. It was evidently a large leaf, and might be derived from a form like *L. giganteum* by an extreme narrowing of the lobes. The next species, *L. Wellingtonii* Lesq., differs from the preceding in having the supposed basal lobes of *L. intermedium* lengthened and curved inward, ascending almost vertically nearly to the tips of the upper lobes. *L. acuminatum* Lesq. differs from *L. Wellingtonii* in having the basal lobes somewhat reduced in length and all of the lobes acuminate. The variety *bilobatum* merely differs from *L. acuminatum* in having the basal lobes bilobate, thus greatly resembling various forms referred to Aralia. Lesquereux compares it with *L. islandicum* S. & M. If it be a true Liriodendron

[19] Diligent search fails to disclose Liriodendron in the extensive European Cretaceous system.

[20] Ueber tertiare Pflanzen aus dem Thale des Flusses Buchtornia am fusse des Altaigebirges. Palaeontographica 33. 1887. *L. Celakovskii* Velen. is probably not a Liriodendron (Bull. Torr. Bot. Club, July 1902).

it is certainly a very anomalous form of leaf, and represents the extreme of development of the lobate leaf in this genus.

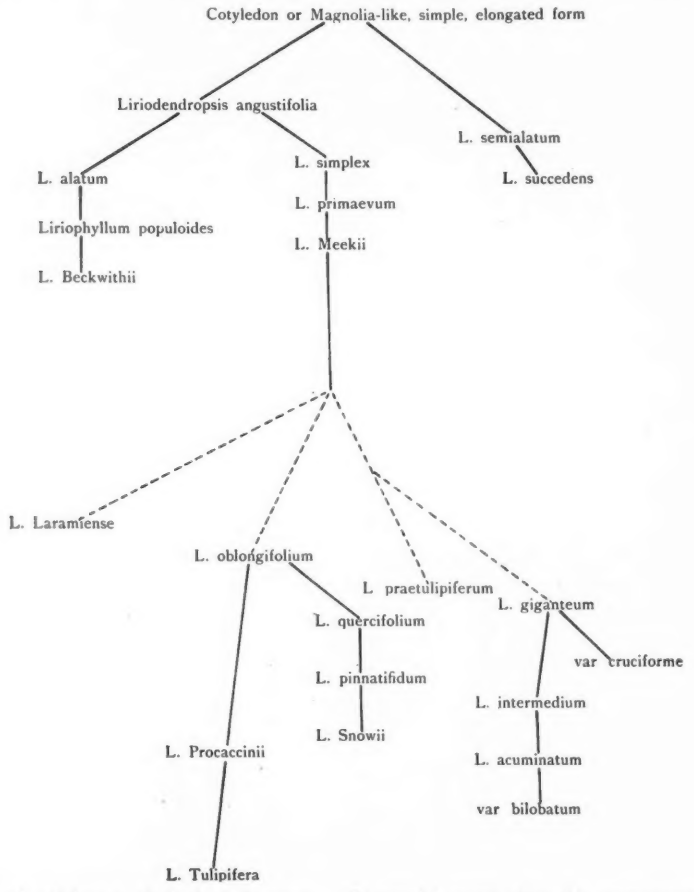
We have next to consider Ward's *L. Laramiense*. It is a more recent species than any of the preceding American forms, being from the Laramie. According to Stanton & Knowlton,[21] these strata underlie marine Cretaceous and therefore belong to the Montana formation. If this reference be correct, it leaves but one American species besides the existing one subsequent to the Cretaceous. If *L. Laramiense* is a true species, the doubt being caused by the known remains consisting of but the basal fragment of a leaf, it was a comparatively simple form which developed from the ancestral *Tulipifera*-like form, which was probably contemporaneous with it, although as yet no *L. Tulipifera* remains have been found in these strata. Modern simple *L. Tulipifera* leaves similar to *L. Laramiense* are very common.

The last fossil form to consider is the remarkable *L. Snowii* Lesq., from the Dakota group. It is a large leaf, ovate in outline, pinnately divided into several linear, obtuse lobes on each side, which are attached by their whole bases to the midrib, but are entirely separated from each other by a considerable interval of free midrib. While it differs so widely from any of the other forms of Liriodendron as to seem to represent an unallied compound leaf, there is something about it that stamps it as a species of Liriodendron. The venation is also typical of the genus. It may represent a further and extreme development from *L. pinnatifidum*, which originated, flourished, and disappeared during the deposition of the Dakota group; we certainly have nothing like it among modern Liriodendron leaves.

With the close of the Dakota period the Liriodendron group seems to wane, having but one or possibly two species in the Laramie, and none in the American Tertiary or more recent formations, although the tulip tree flourished in Europe throughout the Tertiary. While the extremely lobate species may have

[21] Bull. Geol. Soc. Am. **8**: 127–156. 1896.

become extinct after the close of the Cretaceous, it is very probable that the ancestors of the modern tree still flourished, and we can only blame the imperfect geological record for the lack



of evidence of their existence. It would seem that the numerous Tertiary lakes would have furnished abundant facilities for fossilizing leaves from the trees that skirted their shores, or were brought down from the adjacent uplands by the many streams.

Matthew and Davis[22] have recently advanced reasons for considering a considerable number of the so-called Tertiary lake formations to be flood-plain and aeolian deposits. If their arguments are sustained, which seems unlikely except for restricted areas, the absence of leaves from these formations becomes explicable. Be this as it may, the record has thus far proved barren, and we can only congratulate ourselves that the more ancient record is so complete. We can better spare the record of the Tertiary, for the modern form became practically fixed in *L. oblongifolium* of the Amboy clays, or its undiscovered, closely related contemporary, and has changed but slightly in subsequent times.

A summary of these suggested relationships may be presented as on opposite page.

PASSAIC, N. J.

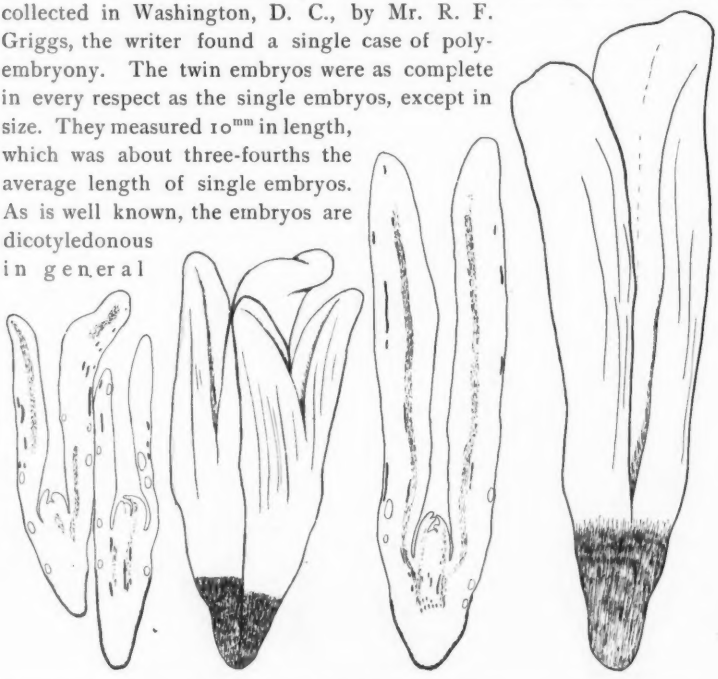
[22] MATTHEW, W. D. Bull Am. Mus. Nat. Hist. **12**: 25. 1899; GILBERT, G. K. 17th Ann. Rep. U. S. Geol. Surv. 1895–6, part 2, p. 575; WILLISTON, Kan. Univ. Geol. Surv. Rep. 1896; see also FRAAS in Science **14**: 210.

BRIEFER ARTICLES.

POLYEMBRYONY IN GINKGO.

(WITH FOUR FIGURES)

Polyembryony is common among the pines, but I have not seen it recorded for Ginkgo. Recently in examining some material of Ginkgo, collected in Washington, D. C., by Mr. R. F. Griggs, the writer found a single case of polyembryony. The twin embryos were as complete in every respect as the single embryos, except in size. They measured 10^{mm} in length, which was about three-fourths the average length of single embryos. As is well known, the embryos are dicotyledonous in general



character, and when sectioned the cotyledons showed an elongation of cells through the long axis, apparently the fibrovascular bundle. The plumules were made up of several leaflets, a branch of the fibrovascular bundle running into each; and near the surface sec-

tions of a number of large resin ducts were observed. The accompanying illustrations are self-explanatory.—MEL T. COOK, *Ohio State University, Columbus, Ohio.*

A ROOT ROT OF APPLE TREES CAUSED BY THELEPHORA GALACTINA FR.

FOR thirty years or more apple growers in West Virginia, Kentucky, southern Illinois, Missouri, Arkansas, and Oklahoma, have lost numerous trees from root diseases of various kinds. The trees attacked were generally young trees, from three to six years old. During the last few years investigations have been carried on in several states, which show that the death of apple and other fruit trees, because of root disease, is due to a number of different diseases; in other words, that the term "root-rot" cannot always be applied to one disease. Several fungi have been associated with root rot diseases. One of these is widely distributed as a parasite of trees in the states mentioned above. Apple trees set out on newly cleared ground are attacked by the fungus very soon after planting. The trees show no signs of disease until the year of death. Diseased trees four and five years old, with their root system almost entirely destroyed, can often be recognized by excessive flower and fruit production, a phenomenon frequently noted when plants are much weakened by disease. Diseased trees die very suddenly, generally in the early summer. The leaves wither and fall and within a few weeks the tree is dead. Diseased trees always occur in groups, which indicates that the fungus spreads through the soil.

The root rot disease caused by Thelephora differs from that caused by *Agaricus melleus* in that no signs of disease are evident above ground until the trees are dead. The fungus causing this disease has been identified by Dr. E. A. Burt as *Thelephora galactina* Fr. The fruiting body consists of bright red orange leathery sheets which form on diseased roots and around the base of the trunk. The fungus was transferred from oak roots to young apple trees, killing the latter within a year.

An extended account of the mode of occurrence and growth of *Thelephora galactina* will be published before long.—HERMANN VON SCHRENK, *Shaw School of Botany, St. Louis.*

STIPA HASSEI NOT A GOOD SPECIES.

(WITH ONE FIGURE)

In Contributions from the National Herbarium 1 : 267. 1893, Dr. Vasey describes several new species of grasses. One of these belongs to the genus Stipa and is named *Stipa Hassei* in honor of its collector.

a *b*

There are five specimens of this species in the National Herbarium, all collected by Dr. Hasse in the region of the Santa Monica range of Los Angeles county, California. The type and a cotype were collected in the spring of 1891, and the other specimens were collected April 5, 1895.

All these specimens are but abnormal forms of *Stipa eminens Andersoni* Vasey, caused by the growth of a smut. The oblong grain, thin glumes, and narrow, short-branched panicles, on which the specific characters of *Stipa Hassei* Vasey are based, are due to the development of this fungus.

In the accompanying figure, *a* shows a spikelet from the type specimen of *Stipa Hassei* Vasey, and *b* a spikelet from the type specimen of *Stipa eminens Andersoni* Vasey. Both are enlarged twice. — ERNEST NORTON WILCOX, *Office of the Agrostologist, Washington, D. C.*

CURRENT LITERATURE.

BOOK REVIEWS.

A university text.[1]

THAT there is need of a good general text-book of botany of university rank, written from the modern standpoint and largely from American material, has long been recognized. Professor Campbell is the first in this field, and his purpose is "to present in as compact a form as possible an outline of the essentials of modern botany." His book treats of anatomy, morphology, general taxonomy, physiology, and ecology, although the chapters are not grouped under such general divisions.

It is a serious question whether the science of botany has not advanced too far for any one man to undertake a general text of university rank. In the nature of things, the writer's own field will be developed much more extensively than the others, which perhaps are equally important as representing the present status of botany. The result will be a university text in one phase of the subject, and a very incomplete and elementary text in the other phases.

It is upon this basis that the book before us must be judged. The matter dealing with general anatomy, morphology, and the outlines of classification, occupies 460 pages. In this field Professor Campbell's standing is assured, and his grasp of the subject and his conclusions are derived from an immense amount of personal investigation. This strong personal element is attractive and useful, even though there may be much diversity of opinion as to many of the statements and conclusions. It is a matter of regret, however, that in a university text so little attention is given to the discussion of such important topics as the origin and evolution of sex, the appearance of the sporophyte, etc. The materials are presented in somewhat encyclopedic fashion, and as the author only intended the book as one of reference, perhaps he has left it to the university teacher to develop his own theories and lines of continuity.

The presentation of physiology occupies only 33 pages, which cannot be claimed to be an adequate expression of the important place of physiology in modern botany, especially from the university standpoint. The great brevity precludes completeness and often clearness, and sometimes

[1] CAMPBELL, DOUGLAS HOUGHTON, A university text-book of botany. 8vo. xv + 579, with 493 figures and 15 plates. New York: The Macmillan Company. 1902. $4.00.

will probably result in misconception. For example, on p. 464, the independence of water and solutes in entering the cell is ignored, although it is fundamental; and on p. 489 there is hopeless confusion between rheotropism and hydrotropism, fundamentally different phenomena.

In the two chapters devoted to ecology, the style is easy and pleasing, but the presentation is altogether too brief and the matter too simple to satisfy elementary instruction in a university. Many would also object to the extreme teleological standpoint. The whole subject of ecology has been making such rapid development that it has become dangerous for one unfamiliar with the great mass of recent work and literature to venture many statements.

Perhaps the most noticeable feature from the standpoint of an organized text is the lack of any typographical organization of captions. Of course it is troublesome to coordinate captions so as to express the proper relationships of subjects, but it is extremely desirable in a text for elementary instruction, even in universities.

After all, the book will stand for a mass of morphological facts, most of which have passed under the author's observation, illustrated to quite an unusual extent by the author's own drawings, and largely derived in a most desirable way from American material. From this standpoint it is very welcome, and will doubtless be largely used, as its author intended, for a book of reference.—J. M. C.

Saccardo's Sylloge Fungorum.

ANOTHER volume of this monumental work, projected and edited by Professor P. A. Saccardo, has come to hand. It is the sixteenth volume,[2] and is of the same notable size and quality as those preceding. The fifteenth volume, devoted to synonymy, and prepared in collaboration with Professor E. Mussat of Paris, has not yet been distributed, although it was expected to appear in 1901. In the present volume are mentioned 4853 species, representing mycological activity during the preceding eighteen months, *i. e.*, from June 1899 to December 1901. Complete diagnoses are given of all the species except 490, which came in so late that only a citation could be entered at the back of the volume. There is an excellent species and host index, and a universal index of genera. The total number of species of the fifteen volumes now aggregates 52,157. In this volume twenty-seven species are described for the first time, and new names are proposed for five species previously published.—J. C. ARTHUR.

[2] SACCARDO, P. A., Sylloge fungorum omnium hucusque cognitorum; supplementum universale, pars V. Auctoribus P. A. Saccardo et P. Sydow. Adjectus est index totius operis. 8vo, pp. 1291. Patavii, 1902. 81 francs.

MINOR NOTICES.

MISS CLARA E. CUMMINGS has published a list of Labrador lichens collected by Professor E. B. Delabarre on the Atlantic coast of Labrador during 1900. The list is a reprint from Bull. Geog. Soc. Phil. 3 : no. 4, and contains 43 species.— J. M. C.

THE EXPERIMENT FARM of the Horticultural Society of North Carolina has published an attractive pamphlet calling attention to the many valuable qualities of the "cow pea" (*Vigna sinensis*). It is a full synopsis of the history, habits, and merits of the plant.— J. M. C.

IT IS VERY FITTING that Dr. Robert Hartig[3] just before his death should have brought together a summary of his publications. The first 52 pages of the work is taken up in brief reviews of his 38 papers. In the remaining portion of the volume the author gives the results of his last work on the influence of gravity, pressure, and pull on the form of the fir and the structure of its wood.— H. N. WHITFORD.

V. KOMAROV has just published[4] the first volume of a *Flora of Manchuria*, including the vascular plants. All of the notes and descriptive text are in Russian, and the Engler sequence is followed, the volume completing the monocotyledons. The pteridophytes are represented by 74 species, the single new one being a Nephrodium ; the gymnosperms comprise 29 species, *Pinus funebris* and *Abies gracilis* being new ; while the list of monocotyledons numbers 461, new species being described in Scirpus, Carex (2), and Lilium. Of the monocotyledons, 86 are grasses and 122 sedges, Carex containing 83 species.— J. M. C.

WULFF[5] has made some recent contributions to the knowledge of arctic plant ecology. The first paper treats of the transpiration of arctic plants. By means of the cobalt paper method the relative transpiration activity of some ten species, each under sixteen different climatic conditions, were determined. The main conclusions are as follows: daily variation in transpiration is absent ; as compared with temperate plants the transpiration is uniformly weak ; there is a frequent falling off of transpiration in relatively high temperatures and low humidity. A second paper treats of the occurrence of anthocyan in arctic plants. The distribution of coloring matter is carefully noted in fifty species. Dried specimens were examined and found to contain abundant sugar and little starch. This is in accord with the experiments of Miyake and others, who found cold conducive to the production of

[3] HARTIG, ROBERT, Holzuntersuchungen. Altes und Neues. vi + 99, with 52 text figures. Berlin : Springer, 1901.

[4] Acta Horti Petropolitani **20** : 1–559. 1901.

[5] WULFF, THORILD, Botanische Beobachtungen aus Spitzbergen. pp. iii + 115, with 4 plates. E. Malmström. 1902.

sugar rather than starch. The author concludes that the excess of sugar causes the appearance of the anthocyan. This conclusion is based upon Overton's experiments. A third paper deals with the distribution of plants on a peculiar formation known as the "Polygonboden." In the last paper the author has collected some miscellaneous floristic notes.— H. N. WHITFORD.

NOTES FOR STUDENTS.

R. KNUTH[6] has begun the publication of the results of his study of *Geranium*. After the general distribution of the genus is presented, each of the twelve sections is considered separately, the present paper including *Unguiculata* (5 spp.), *Subacaulia* (4 spp.), *Tuberosa* (4 spp.), and *Batrachia* (38 spp.).— J. M. C.

IN A PRELIMINARY PAPER[7] on chromosome reduction in *Larix leptolepis* Ishikawa announces a condition similar to that described in his paper on *Allium fistulosum*. In the prophase of the first division of the pollen mother cell twelve pairs of chromosomes appear. The chromosomes of the pair may be variously united, sometimes forming tetrads. In the second division twelve ring-shaped chromosomes are formed. The writer interprets the first division as an "equation division," and the second as a "reduction division" in Weissman's sense. The full paper will appear in *Jour. Coll. Sci. Tokyo.* —W. J. G. LAND.

J. M. GREENMAN[8] has published the general results of his long study of the North and Central American species of *Senecio*. After an historical account of the genus, the morphology of the different plant members is considered, and the classification presented. About 300 species are included, grouped into 22 sections, 14 of which bear Mr. Greenman's name. The subgenus *Eusenecio* O. Hoffm. includes 21 of the sections, and *Pseudogynoxis* Greenm. the remaining one. The species are merely listed under their tribes, 70 of them being unpublished new species. The geographical distribution of the genus as a whole and of each section is presented in concise and tabulated form.— J. M. C.

A NEW INTERPRETATION of the phenomena of sap pressure and bleeding has been set forth by Molisch.[9] He takes the position that all the cases

[6] Uber die geographische Verbreitung und die Anpassungserscheinungen der Gattung Geranium im Verhältnis zu ihrer systematischen Gliederung. Engler's Bot. Jahrb. **32**: 190–208. 1902.

[7] ISHIKAWA, C., Ueber die Chromosomenreduction bei *Larix leptolepis*. Beih. Bot. Centralb. **11**: 6–7. 1901.

[8] Monographie der nord- und centralamerikanischen Arten der Gattung Senecio. Engler's Bot. Jahrb. **32**: 1–33. 1902.

[9] MOLISCH, HANS, Ueber localen Blutungsdruck und seine Ursachen. Bot. Zeit. **60**: 45–63. 1902.

of bleeding which have been observed are pathological phenomena, dependent either upon the stimulus of the wound by which the manometer was brought into the tissue, or upon the development of abnormal tissue (such as callus) covering the wound surface. The pressure arises, then, at or near the wound surface and not far back in the plant body. Many experiments were performed upon *Juglans regia*, *Betula alba*, etc., and all seem to support this idea. The work of Figdor, C. Kraus, Pitra, and Wieler is discussed, and evidence drawn therefrom in support of the new interpretation.— B. E. LIVINGSTON.

M. T. COOK [10] has published the results of a morphological study of *Castalia* (*Nymphaea*) *odorata* and *Nymphaea* (*Nuphar*) *advena*. The development of the megaspore and of the structures of the embryo sac is reported as presenting no new features. The first division of the definitive nucleus is followed by a wall across the embryo sac. In the upper chamber the endosperm develops, while the lower extends as an haustorial tube to the chalazal extremity of the ovule. The embryo is at first a spherical multicellular mass, as described by Lyon and Conard, and later forms what the author, in agreement with Lyon, regards as a single cotyledon. Following Lyon, he would regard this as justifying the transfer of the Nymphaeaceae to the monocotyledons.—J. M. C.

MISS SIBILLE O. FORD [11] has been studying the anatomy and development of *Ceratopteris thalictroides*. She finds that the plant is annual, and is often reproduced by adventitious buds originating in the angles between the lobes of the leaves. The bundles are generally bicollateral, and the cauline bundle system consists of an outer series of large strands and of smaller medullary strands. The developing stelar system does not pass through a siphonostelic phase as in most ferns with numerous vascular strands; but, like certain Nymphaeaceae, breaks up immediately and becomes polystelic. The sporangia are large, and have an imperfectly developed annulus. Miss Ford considers Ceratopteris to be closely allied to the Polypodiaceae, and also to show less marked affinities with the Marsiliaceae.— E. C. JEFFREY.

ROSENVINGE [12] contributes a paper on spiral position of leaves in several species of Polysiphonia. It is somewhat polemic, being directed against Seckt. His figures are meager for the immense amount of mechanics involved. He refutes Schwendener's contact theory, and makes clear the fact that the position of the leaf depends upon the position of the daughter

[10] Development of the embryo sac and embryo of *Castalia odorata* and *Nymphaea advena*. Bull. Torr. Bot. Club **29**: 211–220. *pls. 12–13*. 1902.

[11] The anatomy of *Ceratopteris thalictroides* (L.), Annals of Botany **16**: 95–121. *pl. 6*. 1902.

[12] ROSENVINGE, L. KOLDERUP, Ueber die Spiralstellungen der Rhodomelaceen. Jahrb. Wiss. Bot. **37**: 338–364. *pl. 6*. 1902.

nucleus and the direction of the segment wall. The nucleus assumes such a position long before the wall appears. The leaf immediately below is rarely of sufficient length to reach the apical cell, as Schwendener assumes, and even when it does, stands out from the axis at a very appreciable angle. Even though there appears to be a correlation between the position of the lower leaf and the direction of the segment wall, we must look for some more hidden stimulus than mere physical contact.—JAMES J. WOLFE.

A. G. TANSLEY and MISS R. B. LULHAM [13] in a preliminary note describe a new type of fern stele in species of Lindsaya from the Malay peninsula and elsewhere. The tubular central cylinder has permanently a core of phloem only, and is of considerable interest because it presents in the adult a condition which is a developmental phase only in other siphonostelic ferns. In the same number of the *Annals* GWYNNE-VAUGHN[14] describes a curious axillary organ in *Helminthostachys zeylanica*. He suggests that the structure in question may be a vestigial axillary bud, or perhaps of glandular nature. T. G. HILL [15] makes a preliminary announcement of the discovery of a cambium in the fibrovascular strands of *Angiopteris evecta*. L. A. BOODLE [16] also describes lignification of the phloem in *Helianthus annuus*. Treatment of the sieve-tubes of old stems with phloroglucin and hydrochloric acid brings about the pink lignin reaction, not only in the walls but also in the contents of the tubes.—E. C. JEFFREY.

HUS [17] has published a systematic account of the species of Porphyra of our Pacific coast, with notes on structure and distribution. One is surprised to learn the great length of some of these plants, 325^{cm} being recorded for a specimen of *P. perforata lanceolata*, and over three meters for *P. nereocystis*. There are two forms of attachment; the usual one discoid, and made up of rhizoidal filaments; and the second a cushion-like parenchymatous type. The latter is peculiar to *P. naiadum*, which occurs on Phyllospadix and Zostera, and results in certain interesting peculiarities of growth and structure. The cushion is at first a single layer of cells in thickness, and by marginal growth extends over the leaf surfaces of the eel grass. An indefinite number of fronds may develop from this cushion, any superficial cell having the power of growth. The cushion is therefore a preliminary phase

[13] On a new type of fern stele, and its probable phylogenetic relations. Annals of Botany **16**: 157–164. 1902.

[14] On an unexplained point in the anatomy of *Helminthostachys zeylanica*. *Idem.* 170–173.

[15] On secondary thickening in *Angiopteris evecta*. *Idem.* 173–174.

[16] On lignification in the phloem of *Helianthus annuus*. *Idem.* 180–183.

[17] HUS, T., An account of the species of Porphyra found on the Pacific coast of North America. Proc. Cal. Acad. Sci. Bot. **2**: 173–238. *pls. 20–22.* 1902.

of the Porphyra plant, analogous to the Chantransia condition of Batrachospermum. It is a very advantageous adaptation to insure the continuous production of numerous fronds. No new facts are presented respecting the problem of sexuality in this group, but the observations are rather against the statements of Berthold.—B. M. DAVIS.

IN A SECOND PAPER on the influence of tensions upon cell growth and the direction of new walls Kny[18] concludes that when no other factors are effective, growth takes place in the direction of a pull and at right angles to that of a compressing force. Cross walls seek a direction perpendicular to external pressure upon the dividing cell, but parallel to a stretching tension exerted upon it. There are "internal forces" at work in most living tissues, which tend to prevent this reaction to tensions, "heredity" being apparently the main one. This means, if we judge correctly, that the above principle does not nearly always hold true, but that the direction of growth and of wall-formation is mainly controlled by as yet unknown factors. Perhaps the most definite result of experimentation here recorded is one obtained, at the suggestion of the author, by M. Nordhausen on segmenting eggs of Fucus. Although the first walls in these eggs are normally formed at right angles to incident light, when the eggs are compressed between glass plates these walls always appear perpendicular to the plates, no matter if this direction be parallel to the incident light rays. Kny experimented upon roots of Vicia, Malva, Raphanus, tubers of Ullucus, and stems of Impatiens, Begonia, Bryophyllum, Ampelopsis, Salix, etc. Two plates showing the effect of tensions upon the different tissues accompany the paper.— B. E. LIVINGSTON.

DR. D. H. SCOTT[19] has recently published an account of some interesting fossil stems, chiefly from the Lower Carboniferous of Scotland. Although the specimens described have the Dadoxylon or Araucarioxylon type of secondary wood, they differ strikingly from other known stems of Cordaites in the possession of mesarch bundles of primary xylem. The fossils are grouped under three genera, Calamopitys, Pitys, and Dadoxylon. Calamopitys is characterized by a small pith, surrounded by a few comparatively large mesarch primary wood bundles, and a thick zone of secondary wood. Pitys possesses a very large medulla and numerous mesarch primary strands, which are separated from the secondary wood by a broad interval of parenchyma. Of the third type of stem, *Dadoxylon Spenceri*, Dr. Scott writes: "The importance of *D. Spenceri* lies in its being on the one hand a typical Dadoxylon, with the type of secondary wood which we know belonged to Cordaites, while

[18] KNY, L., Ueber den Einfluss von Zug und Druck auf die Richtung der Scheidewände in sich theilenden Pflanzenzellen (Zweite Mittheilung). Jahrb. Wiss. Bot. **37**: 55–98. 1901.

[19] On the primary structure of certain Palaeozoic stems with the Dadoxylon type of wood. Trans. Roy. Soc. Edinburgh **40**[2]: 331–365. *pls. 1–6*. 1902.

on the other hand it shows in a reduced form primary xylem comparable to that of Lyginodendron or Poroxylon. It suggests, perhaps more strongly than any of the other species described, a truly gymnospermous stem, which may well have belonged to one of the Cordaiteae, but which still retains the last relics of the primary wood-structure characteristic of the Poroxyleae and the Lyginodendreae." The article is illustrated by six plates, two of which are photographic.— E. C. JEFFREY.

L. A. BOODLE[20], in the third of his studies on the anatomy of ferns, supplements the observations of Poirault on the Gleicheniaceae in several important respects. One species, *Gleichenia pectinata*, departs from the protostelic type of central cylinder described by Poirault for a number of other species of the genus in possessing a siphonostelic (solenostelic) cauline fibrovascular system. The stelar tube has internal as well as external phloem and endodermis. Boodle differs from Poirault in his morphological interpretation of the curious masses of brown sclerenchyma surrounded by an endodermis, which are often found embedded in the foliar traces of the Gleicheniaceae. Poirault regards them, even where not actually continuous with the similar very characteristic sclerenchyma of the cortex, as cortical sequestrations included by the stelar tissues. On the other hand, Boodle thinks, because the islands of brown sclerenchyma are sometimes continuous with similar cortical tissue and sometimes not, that no argument for their morphological nature can be drawn from continuity with the cortex or its absence. A complete description is given of the anatomy of the rare and interesting north Australian genus Platyzoma. The central cylinder is siphonostelic with an internal endodermis but no internal phloem. The foliar gaps in this monotypic and extremely xerophytic genus are much more reduced than is the case in the somewhat similar central cylinder of the Osmundaceae.— E. C. JEFFREY.

THE MUCH-NEEDED PROTHALLIUM of Phylloglossum has been obtained and studied by A. P. W. Thomas of Auckland, New Zealand. A preliminary account[21] has been published, but the detailed account, with drawings, is in hand for publication. Although adult plants were abundant, prothallia were very rare, being discovered in only three localities. It is suggested that one of the conditions lacking for the general and annual development of prothallia is the presence of the fungus symbiont that occurs always within the gametophyte. The prothallium is of the subterranean, tuberous type expected. At first an oval tuber is formed, from which arises a cylindrical

[20] Comparative anatomy of the Hymenophyllaceae, Schizaeaceae, and Gleicheniaceae.3. On the anatomy of the Gleicheniaceae. Annals of Botany **15**:703–747. *pls. 38–39.* 1901.

[21] THOMAS, A. P. W., Preliminary account of the prothallium of Phylloglossum. Proc. Roy. Soc. London **69**: 285–295. 1902.

shaft more or less elongated, dependent probably on the depth of the primary tuber. The top of the cylindrical body becomes expanded in various ways and bears the first sex-organs. Finally the whole structure becomes very irregular, and the whole upper part of the mature prothallium is green, excepting the conspicuous archegonial necks. The antheridia and archegonia seem to differ in no important particular from those of Lycopodium. The embryo, immediately on its escape from the prothallium, forms the protocorm, whose "pedicel" elongates and thrusts it to a safe depth (about 3^{mm}). Crié's claim that he sowed the spores of Phylloglossum and obtained a colorless prothallium like that of Ophioglossum can only be explained on the hypothesis that he saw merely the primary tuberous portion of the prothallium, for the later and conspicuous part becomes even vividly green. On the whole, the prothallium resembles that of *Lycopodium cernuum* nearer than any other. Bower's observations of the occasional branching of the strobilus, and of a leaf some distance below the strobilus, are confirmed; but this leaf was always a sterile sporophyll, and no transition between protophyll and sporophyll was observed. Bertrand's claim that Phylloglossum is a reduction form on account of its semiaquatic habit is controverted by the fact that the plants grow better on a hilltop than on the slope, and Thomas never found them in an actual swamp. The writer inclines to the view of those who regard Phylloglossum the most primitive of living Lycopodiales.— J. M. C.

KARSTEN, in describing the embryology of the Juglandaceae,[22] emphasizes features in which this group resembles the gymnosperms, and expreses his belief that the angiosperms are derived from the gymnosperms, Gnetum being the point of contact. The forms studied were *Juglans regia*, *J. cordiformis*, *J. nigra*, *Pterocarya fraxinifolia*, *Carya amara*, and *C. tomentosa*. In *Juglans cordiformis* at the time of fertilization, and even later, the union of the carpels is delayed, thus leaving the ovules exposed, so that the condition hardly differs from that in those gymnosperms with orthotropous ovules, as Gnetum. There is an extensive sporogenous tissue in the nucellus, but any further development is usually restricted to a single cell in the median plane. The megaspore mother cell may develop directly into the embryo sac, or may first give rise to a row of three or four megaspores, the two upper of which never develop, but the two lower seem to have an equal chance. Many cases were found in which there were two embryo sacs in the median plane, lying one above the other, sometimes touching each other at the ends, but often separated by several layers of sterile cells. A case is figured in which the sac nearest the chalaza had been fertilized. In *Juglans nigra* the egg cannot be distinguished from the synergids before fertilization. There is probably no fusion of the polar nuclei, and if it takes place at all it occurs

[22] KARSTEN, GEO., Ueber die Entwicklung der weiblichen Blüthen bei einigen Juglandaceen. Flora **90**: 316–333. *pl. 12.* 1902.

very late. Double fertilization was observed, and the writer believes that in all cases the union of the male nucleus with the polar nucleus takes place earlier than the fertilization of the egg. Although the occasional occurrence of ambisporangiate flowers may indicate a reduced rather than a primitive condition, the Juglandaceae are to be regarded as one of the lowest families of the angiosperms.

Professor Karsten's arguments for the derivation of angiosperms from gymnosperms are based upon embryological characters, and the most important points are well summed up in his diagrammatic comparison of the embryosacs of Gnetum and the angiosperms, as follows:

Gnetum		*Angiosperms.*
Prothallium in lower part	=	Antipodals.
Egg cells	=	Egg cell and synergids.
Endosperm nuclei	=	Polar nuclei.
The stimulus to development of embryo and endosperm by fertilization of at least two egg cells.	=	The stimulus to development of the embryo by fertilization of the egg, and development of endosperm by vegetative reproduction.

CHARLES J. CHAMBERLAIN.

ITEMS OF TAXONOMIC INTEREST are as follows: J. K. SMALL (Torreya **2**: 74. 1902) has described a new Helianthus from the sea beach of Florida. — F. S. EARLE (Bull. N. Y. Bot. Garden **2**: 331–350. 1902) has published the first of a series of papers entitled "Mycological studies." It contains the announcement of the genus Ascocorticium in North America; a synopsis of the North American species of Periconia, 11 being recognized, 3 of which are new; and descriptions of 28 new fungi, *Hypodermopsis* (Hypodermataceae) and *Ohleriella* (Amphisphaeriaceae) being new genera.— R. S. WILLIAMS (*idem* 351–380. *pls. 34–39*) has published a preliminary list of Montana mosses, including new species of Dicranum and Barbula.— R. PILGER (Engler's Bot. Jahrb. **32**: 53–55. 1902) has described a new African genus (*Acritochaete*) of grasses (Paniceae).— W. SCHMIDLE (*idem* 82) has described a new African genus (*Characiella*) of Protococcaceae.— A. ENGLER (*idem* 108–125) has described the following new African genera: *Lepidobotrys* and *Nectaropetalum* (Linaceae), *Pedaliophyton* (Pedaliaceae), and *Pistaciopsis* (Simarubaceae).— E. GILG (*idem* 139) has described a new African genus (*Dekindtia*) of Oleaceae.— V. S. WHITE (Bull. Torr. Bot. Club **29**: 251–280. *pls. 14–18*. 1902) has published a revision of the Nidulariaceae of North America, *Cyathia* P. Br. (*Cyathus* Haller) containing thirteen species, one of which is new; *Crucibulura* Tul. with one species; *Nidula*, a new genus containing two species, one of them new; and *Granularia* Roth with three species, two of them new.— MARSHALL A. HOWE (*idem* 281–289) in "Notes on American Hepaticae," discusses *Cephalozia connivens*, *Telaranea*, *Arach-*

niopsis, and *Riccia Campbelliana*.— DAVID GRIFFITHS (*idem* 290–301) has described new western species of Tilletia (2), Ustilago, Sorosporium (2), Gymnoconia, Puccinia (3), Æcidium (2), and Claviceps.— ELMER D. MERRILL (Bull. 9, Bureau Plant Industry, Depart. Agric.) has published a revision of the North American species of Spartina, recognizing nine, one of which (*S. Bakeri* from Florida) is new.— C. R. ORCUTT (West Am. Sci. **12**: 163–164. 1902) has described new species of Mamillaria (2) and Echinocactus.— A. P. MORGAN (Jour. Mycol. **8**: 4. 1902) has described a new genus (*Acontium*) of fungi related to Cephalosporium, and containing three new species.—B. L. ROBINSON (Rhodora **4**: 135–137. 1902) has described a new species of Hypericum (*H. Bissellii*) from Connecticut.— M. L. FERNALD (*diem*——) has described a new species of Scutellaria (*S. Churchilliana*) from Maine.— H. M. HALL (Univ. Calif. Publ. Bot. **1**: 1–140 *pls. 1–14*. 1902) has described from the San Jacinto mountain new species of Elymus, Stipa, Oxytheca, Potentilla (2), and Erigeron.— J. M. C.

THE RUSTS OF CEREALS, especially the question of the transmission of the disease by means of the seed, is made the subject of a recent paper by Dr. J. Eriksson [23] in the first two issues of the *Annales des Sciences Naturelles* of the present year. The author reviews the sets of experiments made during the years 1892 to 1899 to grow wheat, oats, and barley in pots protected from atmospheric contagion by glazed cases of different designs, or by inserting the part above ground of single plants into stoppered glass tubes. In spite of the most careful protection rust appeared on the plants. The possible sources of this infection are discussed in detail, and by a process of exclusion the conclusion is reached that it came through the seed, and not from spores floating in the air, as generally assumed. In taking up the problem of the form in which the fungus hibernates in the seed, it is shown that the generally accepted view, that the mycelial life of the yellow rust (*Puccinia glumarum*) may extend throughout the winter and up to the following harvest time, is most likely an error. It is more probable that the rust which persists through the winter dies out in spring, and that both the yellow rust (*P. glumarum*) and the black rust (*P. graminis*) possess mycelium having about the same life period, and that the summer infection for both originates in essentially the same manner. Seeds from rusted plants, it is asserted, are capable of giving rise to rusted plants, with no external source of infection; and the author believes that the rust fungus exists in the seed in a mycoplasmic form, and may so exist as long as the seed is viable. Seeds sometimes bear sori filled with teleutospores, but it is not from these spores that the infection is derived

While it is impossible to demonstrate the mycoplasm, the fungus for the

[23] Sur l'origine et la propagation de la rouille des céréales. Ann. Sci. Nat. Bot. VIII. **15**: 1–160. *pls. 1–5*. 1902.

time having lost definite form and become intimately associated with the protoplasm of the host, yet many observations and experiments are arrayed by the author in proof of its existence. Moreover, certain analogous states have been observed in other organisms. Among the most striking instances are Rozella and Woronina, belonging to the Chytridineæ, and parasitic on Saprolegnia. According to the studies of Cornu and Fischer, when these plants penetrate the host they become diffused for a time in the protoplasm of the cell, and are then quite unrecognizable. Afterward they assume the usual form and produce spores. In accordance with this theory rust may be checked by treating the seed in a manner to kill the mycoplasm. A change of climate, conditions of growth, etc., may also cause the death of the mycoplasm, which will account for the fact that seed from rust-infested fields when taken to another locality or a distant country often gives plants free from that particular kind of rust.

In the third part of the paper the author discusses the various points raised by different writers who have expressed an opinion upon the subject. Only two American mycologists are mentioned, H. L. Bolley and M. A. Carleton. The paper closes with a bibliography of works cited, naming over forty authors and probably twice as many titles.—J. C. ARTHUR.

NEWS.

PROFESSOR C. S. SARGENT has been elected a foreign member of the Linnean Society of London.

MR. C. G. PRINGLE, the veteran collector, has been appointed keeper of the herbarium of the University of Vermont.

PROFESSOR M. TREUB will be absent from Buitenzorg from May, 1902, to March, 1903, his address being Amsterdam.

SIR WILLIAM THISELTON-DYER, director of the Kew Gardens, has been appointed to the post of "Botanical Adviser" to the colonial Secretary of State.

DR. WILLIAM J. GIES, adjunct professor of physiological chemistry in Columbia University, has been appointed consulting chemist to the New York Botanical Garden.

DR. E. C. JEFFREY, Instructor in botany in the University of Toronto, has accepted a call to Harvard University, bearing the official title Assistant Professor of Vegetable Histology and General Morphology.

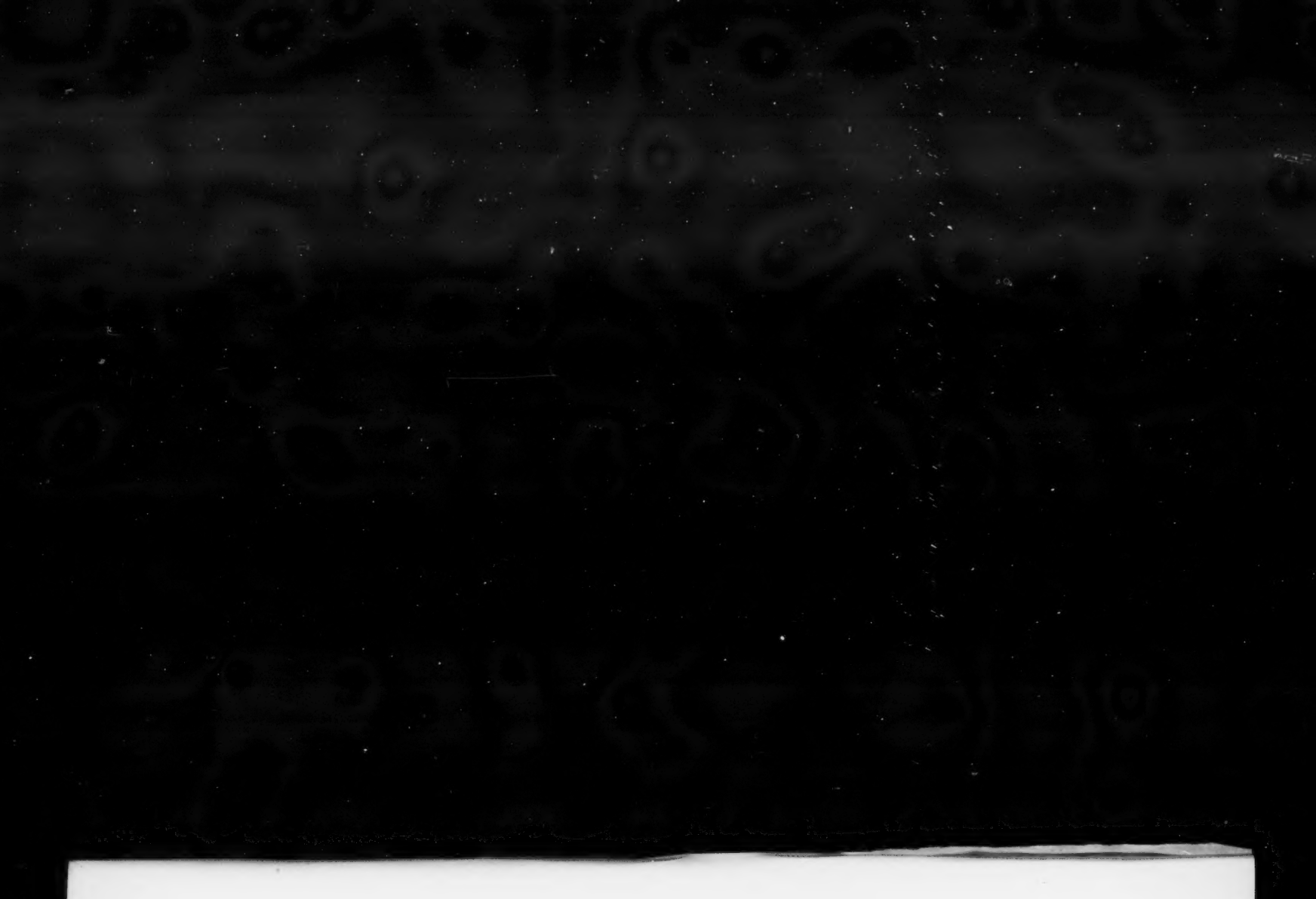
PROFESSOR D. H. SCOTT has been elected Botanical Secretary of the Linnean Society to succeed Mr. B. D. Jackson, who has served in that capacity since 1880, and who now becomes General Secretary.

DR. F. L. STEVENS, instructor in charge of the department of biology of the North Carolina College of Agriculture and Mechanic Arts, has been promoted to the full professorship, and also appointed consulting biologist to the Experiment Station.

MISS LAETITIA M. SNOW has been awarded the fellowship given by the Baltimore Association for the advancement of University Education of Women. She will use the fellowship in continuing her botanical studies at the University of Chicago.

A VERY PRETENTIOUS "art portfolio," entitled "La grande flora de Colorado de Montana y Llanos," has been published by Frank S. Thayer, of Denver, Colorado. The only interest to botanists is that the series consists of illustrations, reproduced from water colors, of twelve "native wild flowers." The descriptions were prepared by Mrs. S. B. Walker, the well-known collector and cultivator of Colorado flowers. Her work has been exceptionally well done, excepting in so far as she has been handicapped by the requirements of publication and lack of competent proofreading.

THE *Journal of Mycology* has been revived by its founder, Professor W. A. Kellerman, now of Ohio State University. The original editors, Messrs. Kellerman, Ellis, and Everhart, conducted it for four years, when it passed under the control of the U. S. Department of Agriculture. Under this arrangement three volumes (1889–1894) were issued. After an interval of eight years it has now reappeared as a quarterly, the first number of the eighth volume being published in May last. Such a journal should find ample support among the rapidly increasing number of professional mycologists. The annual subscription is one dollar.

THE SUBJECTS for the Walker prizes in Natural History, of interest to botanists, are as follows: For 1903, "A monograph of any genus or group of Thallophytes;" for 1904, (1) "The reactions of organisms to solutions considered from the standpoint of the chemical theory of dissociation," (2) "Relations of plants to electricity," (3) "A statistical study of the relative cross-fertility between the varieties of a species." For the best memoir a prize of $60 may be awarded. If, however, the memoir be one of marked merit the amount may be increased to $100 at the discretion of the committee. Information concerning the details of the competition may be obtained from Glover M. Allen, Secretary, Boston Society of Natural History.

AS A RESULT of a series of experiments begun at Clemson College in 1901, and brought to a successful completion in the laboratories of the New York Botanical Garden, Dr. Alex P. Anderson has developed a method by which, with the application of heat to starch grains and to air-dry starch in many forms, the granules or particles are expanded many times their original dimensions, being fractured into innumerable fragments during the process. As a result of this treatment a grain of rice is expanded to eight or more times its original volume, while still retaining its original form. Other cereals exhibit similar behavior. The process is applicable to nearly all starchy seeds and starchy substances, greatly increasing their nutritive availability. The products obtained are pleasant to the taste, and the process may be varied to produce a great variety of flavors with any given cereal. Furthermore, the material prepared in this manner is absolutely sterilized and may be preserved or stored for long periods. The approval the products have met from food and chemical experts suggests that the process may prove of great economic and commercial value.